ORDNANCE

LAND · SEA · AIR

The Ultimate Weapon

JULY-AUGUST 1955

We make our own fine alloy steel—and make it nickel-rich—to make TIMKEN® bearings tougher

NICKEL makes steel tougher. So, our steel-making specialists don't skimp on nickel in the fine alloy steel we make for Timken® tapered roller bearings. They use exactly the right amount of nickel to give these bearings the toughness they need to withstand shock and last longer. Exacting quantities of chromium or molybdenum or both guarantee uniform hardness. By using the steel industry's first direct-reading spectrometer, we exercise hairline control of each element at the precise instant of tapping the furnace.

Rolling, annealing, and cooling are done with the same meticulous care. And every race and roller that goes into a Timken bearing is precision case-carburized to give it a hard, wear-resistant surface over a tough, shock-resistant core.

We've been specializing in the production of fine alloy steel for almost forty years. We're the only bearing manufacturer in the country that makes its own steel, because it's the only way we can make sure the quality of our bearing steel is just the way we want it. Steel is the heart of the bearing. That's why we insist on controlling bearing quality *every* step of the way—from melt shop to final bearing inspection. And that's why we don't skimp on the use of nickel.

To be absolutely sure of the highest performance standards in the equipment you build or buy, always specify Timken tapered roller bearings. They are made from seamless tubing or forgings by the most modern processes, under strict control. Only Timken bearings roll so true, have such quality thru-and-thru. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

Only **TIMKEN**® bearings roll so true, have such quality thru-and-thru

ORDNANCE

LAND · SEA · AIR

The Magazine of Scientific and Industrial Preparedness

VOL. XL JULY-AUGUST 1955 NO. 211

The Cover.—*Is the ultimate weapon the nuclear bomb or the foot soldier with his gun? Recent tests indicate that the combination of both makes an unbeatable team.*

Editor: Leo A. Codd. *Managing Editor:* R. E. Lewis. *Editorial Staff:* M. L. Van Horn, R. K. Smith.

Contributing Editors: J. J. O'Connor, F. W. Foster Gleason, T. K. Vincent, J. M. P. Wright, R. J. Warfel.

Staff Assistants: G. C. Anderson, M. L. Bowers, W. P. Cooke, G. M. Crump, F. G. Ferriter, M. E. Ferriter, G. Y. Garza, K. C. Hankey, J. H. Nicolson, A. Orwiler, D. P. Perakis, E. W. Rendelman, B. M. Rounds, M. P. Stevens, M. J. Webb, N. A. Woodhouse.

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Hunting—and the Fighter Who Rode Black Nell

It took death to stop Bill Hickok's search for adventure. This legendary figure scouted for the Army in Indian campaigns . . . spied far behind Confederate lines . . . and, as marshal, brought law where there was no law. Only natural such a man should turn to hunting and enjoy it to the hilt.

Wild Bill's enthusiasm for the hunt can be seen in a youth's letter to his mother: ". . . I quit writing to go hunting. Now I thought I would write and tell what luck I had. One young buck and two turkeys, which I carried home on my back." And this enthusiasm grew with his marksmanship. Though Buffalo Bill was a close friend, Hickok's pride in his own skill led him to say: "Cody kills Buffalo with a rifle. I can kill 6 buffalo with my pistol while he is killing one." Wild Bill's gun was his creed—and he lived by it.

Since pre-Revolutionary days, Americans have found in hunting the thrilling action and keen enjoyment they look for in a pastime. It's a sport that challenges wits, reflexes, stamina and skill. Equally important, hunting serves to build self-reliance and endurance . . . a valuable contribution to our nation's well-being.

Today, the great American tradition of hunting can be perpetuated only by thoughtful preservation of wildlife. Throughout the country hunting associations are cooperating with public agencies to promote proper conservation. Do your part in preserving this heritage—join or support one of these groups now. E. I. du Pont de Nemours & Co. (Inc.), Explosives Dept., Wilmington 98, Delaware.

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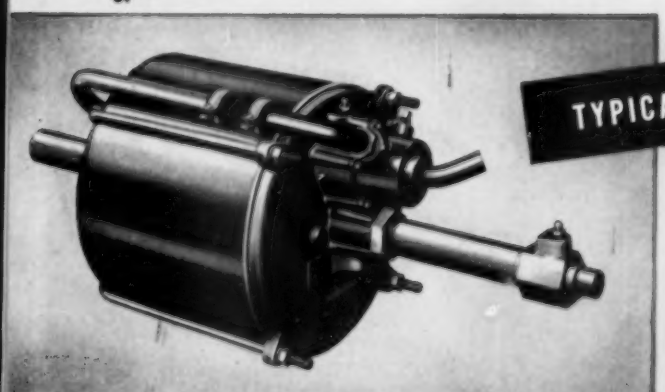
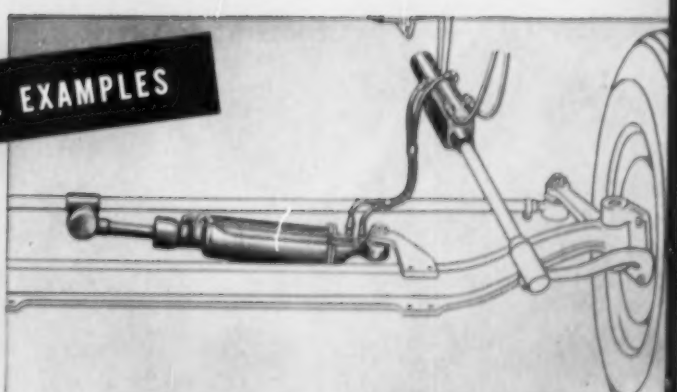


TYPICAL EXAMPLES



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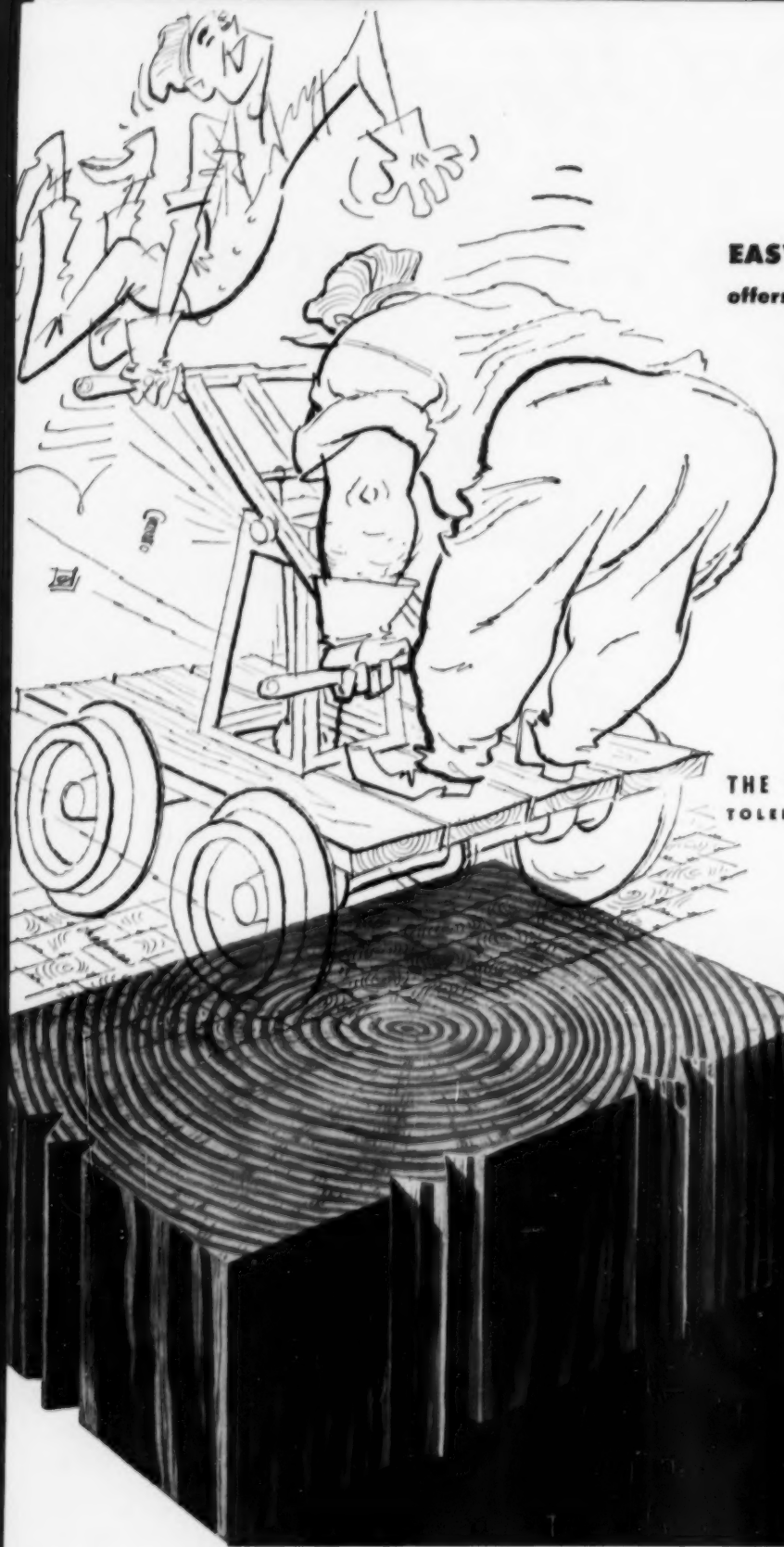

EASY TO TRUCK OVER

offers low tractive resistance*

This is no place for a RR hand car but you'll have to admit it brings back memories and demonstrates a point. Remember how it seemed to roll on and on with so little effort over the smooth rails? Actually the straight and level tracks offered a minimum of tractive resistance and similarly "Kreolite" Wood Block Floors provide excellent trucking surfaces.

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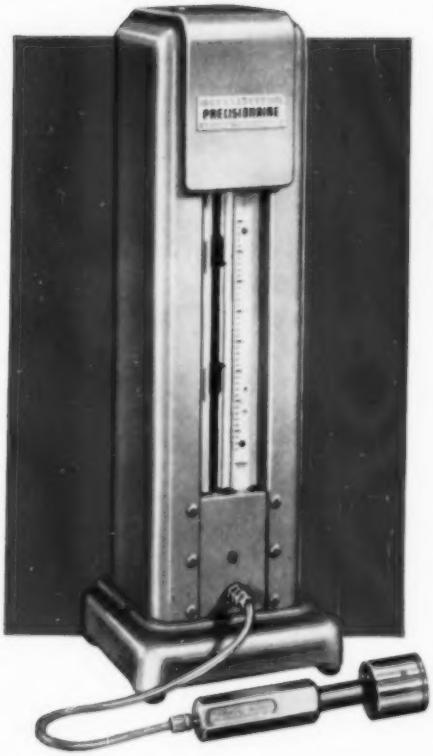

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YOUR PRECISIONAIRE

Immediate conversion to meet an engineering change, a shift from one part to another or a change in tolerance or processing —is an unequalled and exclusive advantage of Precisionaire Column Instruments.

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manufacturer of ordnance for over 100 years

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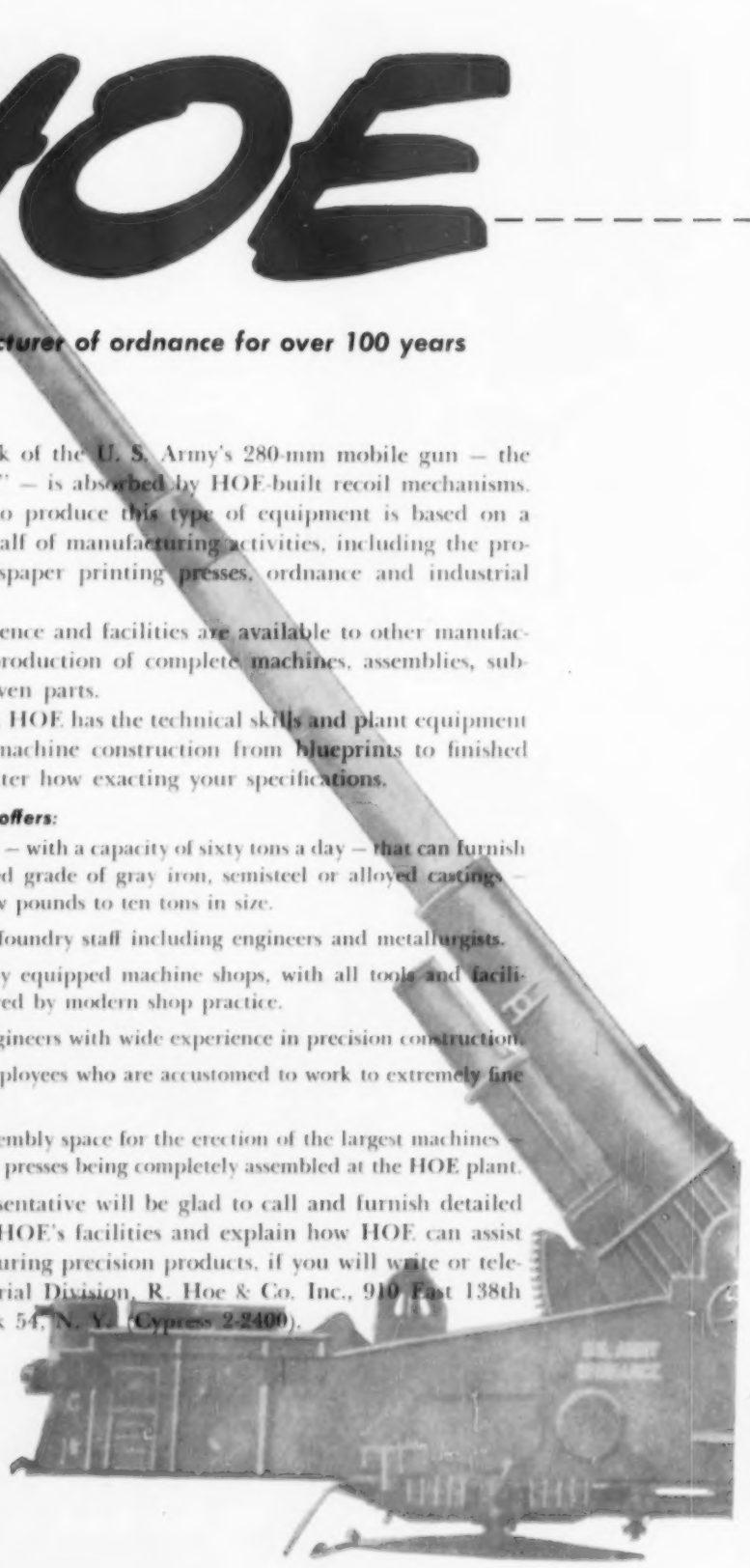
HOE's experience and facilities are available to other manufacturers for the production of complete machines, assemblies, subassemblies, or even parts.

For such work HOE has the technical skills and plant equipment to handle any machine construction from blueprints to finished product, no matter how exacting your specifications.

Specifically HOE offers:

- A foundry — with a capacity of sixty tons a day — that can furnish any desired grade of gray iron, semisteel or alloyed castings — from a few pounds to ten tons in size.
- A skilled foundry staff including engineers and metallurgists.
- Completely equipped machine shops, with all tools and facilities required by modern shop practice.
- Design engineers with wide experience in precision construction.
- Skilled employees who are accustomed to work to extremely fine tolerances.
- Ample assembly space for the erection of the largest machines — newspaper presses being completely assembled at the HOE plant.

A HOE representative will be glad to call and furnish detailed information on HOE's facilities and explain how HOE can assist you in manufacturing precision products, if you will write or telephone to Industrial Division, R. Hoe & Co. Inc., 910 East 138th Street, New York 54, N. Y. (Cypress 2-2400).



builds the recoil mechanisms

for the Army's 280-mm "atomic cannon"

INDUSTRIAL DIVISION

R. HOE & CO., INC.

910 East 138th Street • New York 54, N. Y.

1805 150 1955

They get paid to wreck Zenith's products!

THERE ARE MEN who actually spend all their working hours deliberately trying to wreck precision-built Zenith products.

We have found these people purposely dropping packed radio and television sets three feet onto a concrete floor. They put radios in a "steam bath". They subject many defense products to extremes of temperature, humidity, and salt spray. Or they might put any Zenith product in a machine that shakes and punishes it mercilessly—the equivalent of 5000 miles of *roughest* travel.

And we pay them to do it! We like to be sure that our products will take the worst that can happen to them, even though they'll be pampered and treated with care by their ultimate owners.

Sets must be transported by truck or train to their destinations, and that means a lot of shaking. A Zenith Trans-Oceanic® Portable Radio often turns up in a steaming jungle—or in the arctic. Defense products may turn up anywhere in the world.

That's why at Zenith some men spend their full time trying to wreck Zenith sets. If they succeed, and the sets don't measure up to the highest standards of Zenith quality, even more protection is built in. This is an integral part of our "Quality Assurance" program.

The same care in manufacture, the same "Quality Assurance" program, is carried through all Zenith production—both civilian and defense. This is one reason why Zenith is called on so often to help develop better weapons of defense for the Government.

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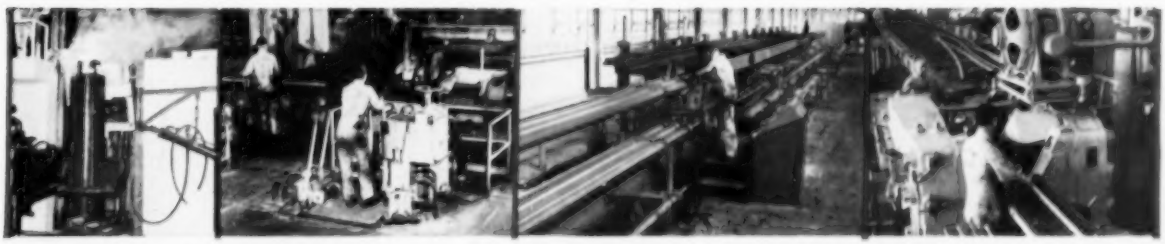
ZENITH, *backed by 36 years of specialization in radionics, serves America with a* STRONGER DEFENSE AND A BETTER WAY OF LIVING

IS FOR QUALITY

. . . in rotating bands

as well as other tubular products

If you use copper or gilding metal rotating bands—or if you require copper, aluminum or electric-welded steel tube or tubular products—Wolverine is the best bet as your "Number 1" supplier. The reason: quality! Here is an example of how we build in that quality:

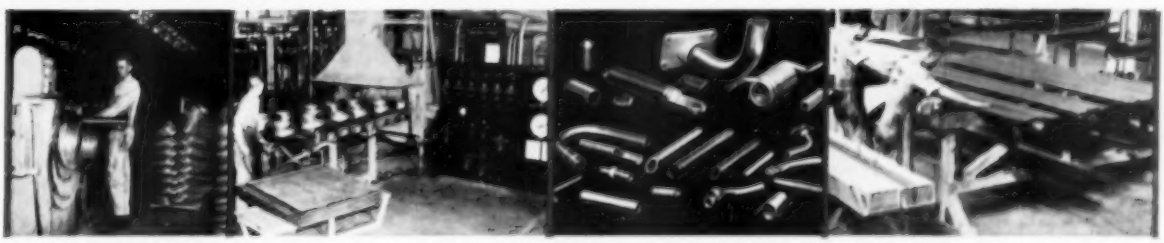


Raw copper is cast into billets and then sawed into extrusion blocks.

Pressure up to 2400 tons is available to extrude the pre-heated copper block into a base tube. (Piercing facilities are also available.)

Batteries of draw benches reduce the base tube to the diameter and wall thickness required.

Wolverine straight tube can be rolled on a flat surface without evidence of whip.



Some industries require tube in lengths too long to conveniently handle. For them, tubing is coiled.

When the tube is required soft for bending or other purposes, it is annealed in a controlled atmosphere furnace.

Fabrication—finning, bending, swaging, beading, flaring, spinning—are available upon special order.

Inspectors follow the tube through every step of the manufacturing process. This assures complete quality control . . . and that customer requirements are rigidly adhered to.

This is a synopsis of the story of the manufacture of copper and copper base alloy tube at Wolverine. The same careful attention to detail is followed in the production of aluminum tube and shapes and steel tube, too. It adds up to one source for quality products . . . Wolverine Tube! WOLVERINE TUBE, 1499 Central Avenue, Detroit 9, Michigan.

Write today for the Wolverine General Products Catalog

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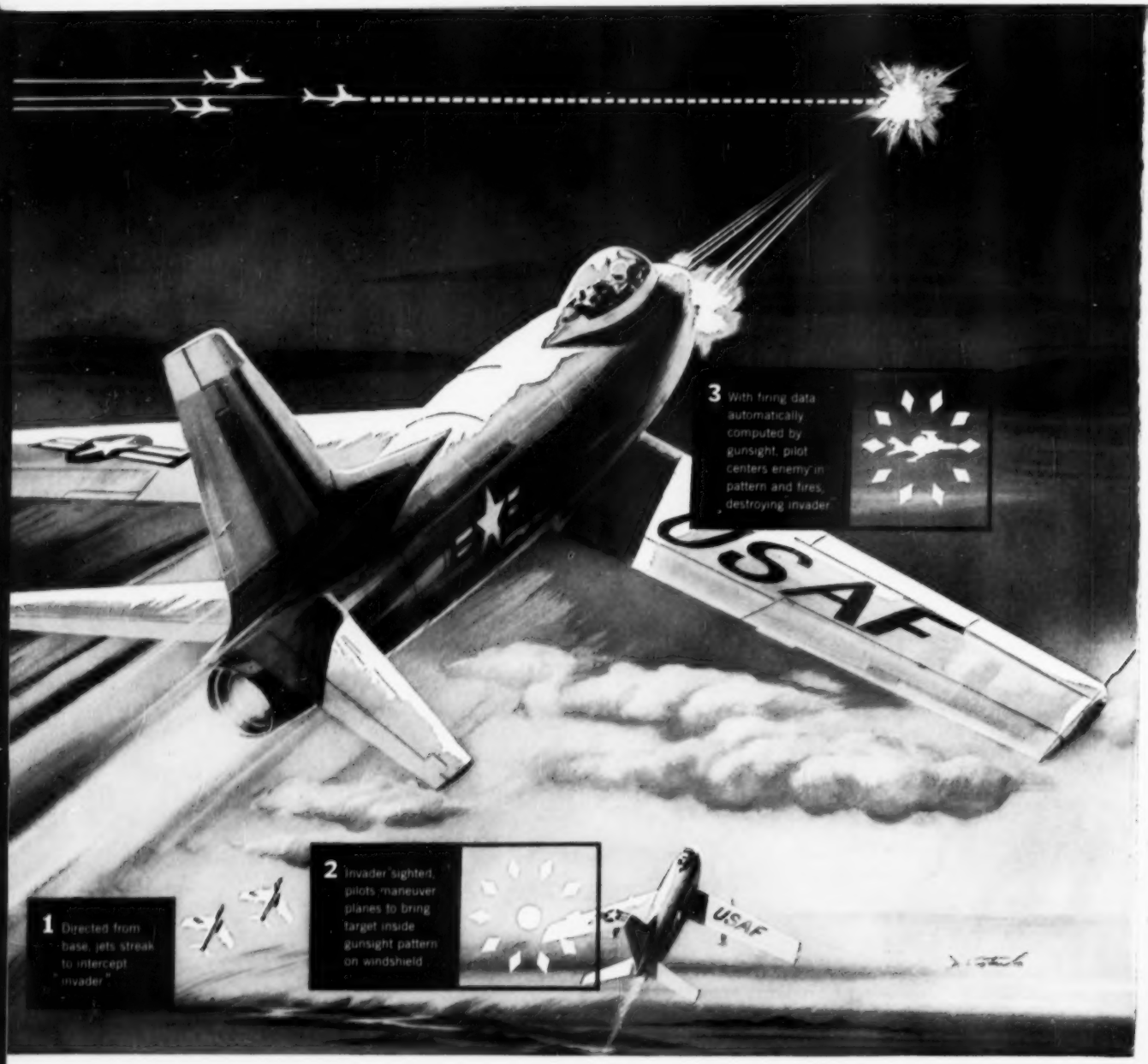
1 Directed from base, jets streak to intercept "invader."
2 Invader sighted, pilots maneuver planes to bring target inside gunsight pattern on windshield.
3 With firing data automatically computed by gunsight, pilot centers enemy in pattern and fires, destroying invader.
USAF

RADAR GUNSIGHT HELPS TAC PILOTS BAG "FOE"

Korean-tested Device Proves Deadly Accurate in Stopping Jet "Invaders"

THE STORY BEHIND THE STORY:

Here at home, where air defenses are constantly being strengthened, there's a good chance of detecting and intercepting hostile planes before they reach their destination. And abroad, as you've probably noticed from headlines like the one above, chances are good that aggressors would be intercepted and shot down by fighters from our overseas bases or from NATO wings.

One reason for the impressive marksmanship demonstrated by Tactical Air Command pilots, of course, is their intensive training. Another is the accuracy of the computing gunsight first used in Korea and now serving TAC and NATO squadrons. Here's what it does, in the words of General "Jimmy" Doolittle:

"In jet combat you are chasing a small and elusive speck, and you have only seconds to shoot at it. You are travelling ten miles per minute, twisting and turning; your senses can't measure the speed and range of the target or the angles involved in hitting it—and even if they could, you lack time for necessary calculations. The new gunsight does this for the pilot. He watches an illuminated circle and dot reflected on his windshield. When circle and dot are superimposed on the target, he fires."

Developed through the joint efforts of the Instrumentation Laboratory of M.I.T. under Director Dr. C. Stark Draper, Sperry, and U.S.A.F.'s Armament Laboratory—the radar gunsight is an example of teamwork at its best – providing better weapons for defense efficiently and economically.

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. . . Meet necessary rigid standards

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Stretching the Path of an Electronic Pulse

Military coding equipment takes one pulse and inserts it into a delay line and in effect sends it over a number of paths, each of different lengths. Combining the output of the paths gives a pulse train with pulses spaced in accordance with artificial length of the path. Ordinarily the flexibility of the equipment is limited by the fixed taps in the delay line and the accuracy is established by auxiliary circuitry.

Now Admiral research has developed a completely new type of delay line which is infinitely variable within its over-all capacity. It is adjustable with the greatest facility for any desired interval. The accuracy of this line is limited only by the accuracy of the measuring equipment. Moreover, the Admiral delay line requires less complicated switching apparatus. Weight and bulk are reduced. Fewer components permit faster production at lower cost. Here is one more example of Admiral's capabilities in the field of military electronics. Address inquiries to:

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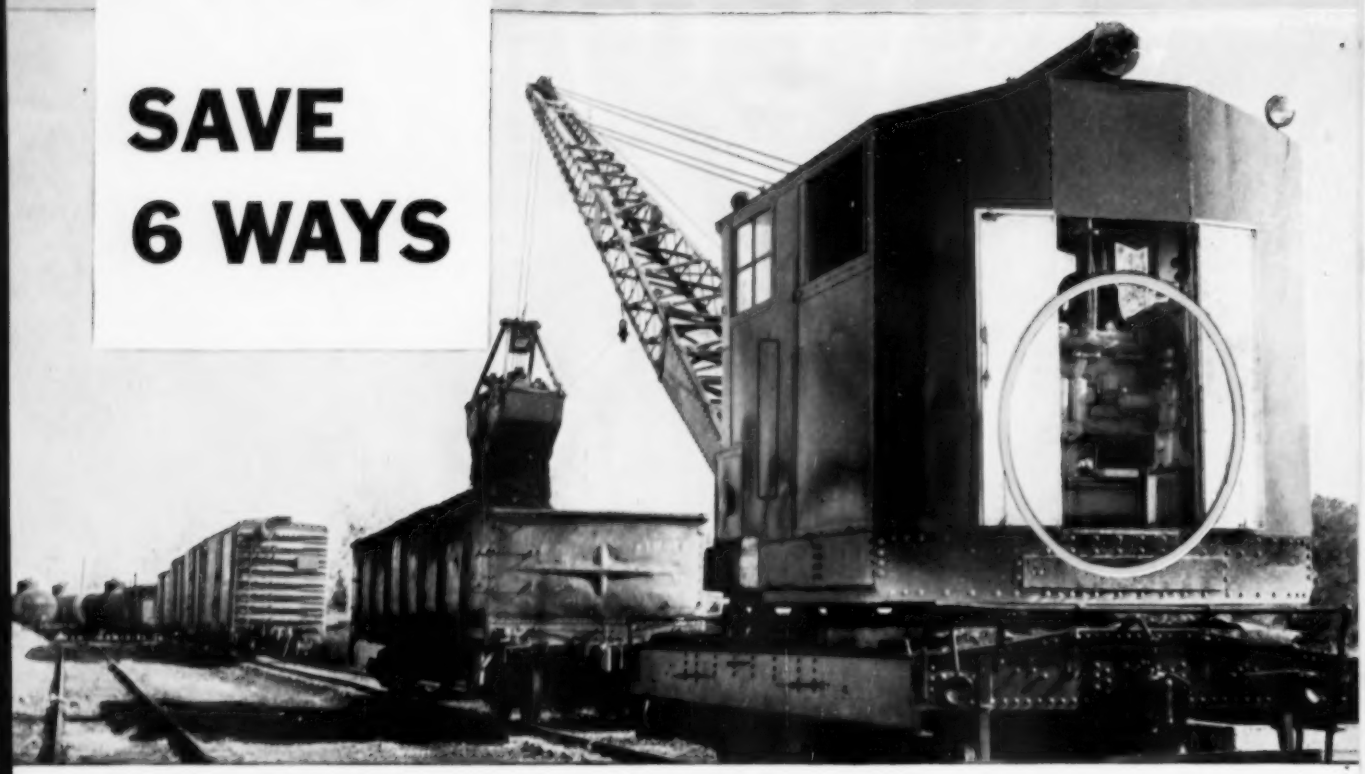
How you can get new-crane performance and

SAVE 6 WAYS



If you handle bulk material, do what this Colorado sugar company did. Switching from steam to Caterpillar power cut material handling costs. A CAT* D318 Torque Converter Power Unit has given this locomotive crane new life. Here it loads coal at the company's Windsor, Colorado, factory. Converting cranes from steam to Cat Diesel pays off:

1. ***Always ready to work.*** There's no need to fire up a Caterpillar Diesel ahead of time. It starts quickly and positively—even in coldest weather—and gets down to business *fast*.

2. ***Shuts down completely.*** You feed the "horses" in Caterpillar Engines only when they work. There's no stand-by firing at night or over week ends.

3. ***Low hourly cost.*** Caterpillar Diesels give full and *foul-free* power for pennies per hour on low-cost fuel such as No. 2 furnace oil. You can rely on the ruggedness of Caterpillar power units for easy maintenance, low down time, small repair bills.

4. ***High work output.*** Cat Diesel Torque Converter Power Units give smooth, load-matching power. Power that gives extra pull under heavy loads and extra speed on light loads. And they do it *without stops* for fuel and water!

5. ***New-machine performance at low price.*** Caterpillar Engines and torque converters can be matched to your job. There are honestly rated units to 520 HP, with compounded units available for even greater flexibility.

6. ***Dependable advice and service.*** Ask your Caterpillar Dealer—who can provide skilled service and genuine factory parts—about these power units. He'll give you specifications and data to help you plan your torque converter installation. He'll be glad to see you—make it soon!

Caterpillar Tractor Co., Peoria, Illinois, U.S.A.

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"Bogey at 6,000 miles!"

Sure, six thousand miles is beyond the range of today's radar equipment. But radar has been so highly developed since the end of World War II that who's to say how long it'll be until we're thinking in terms of thousands of miles . . . or more?

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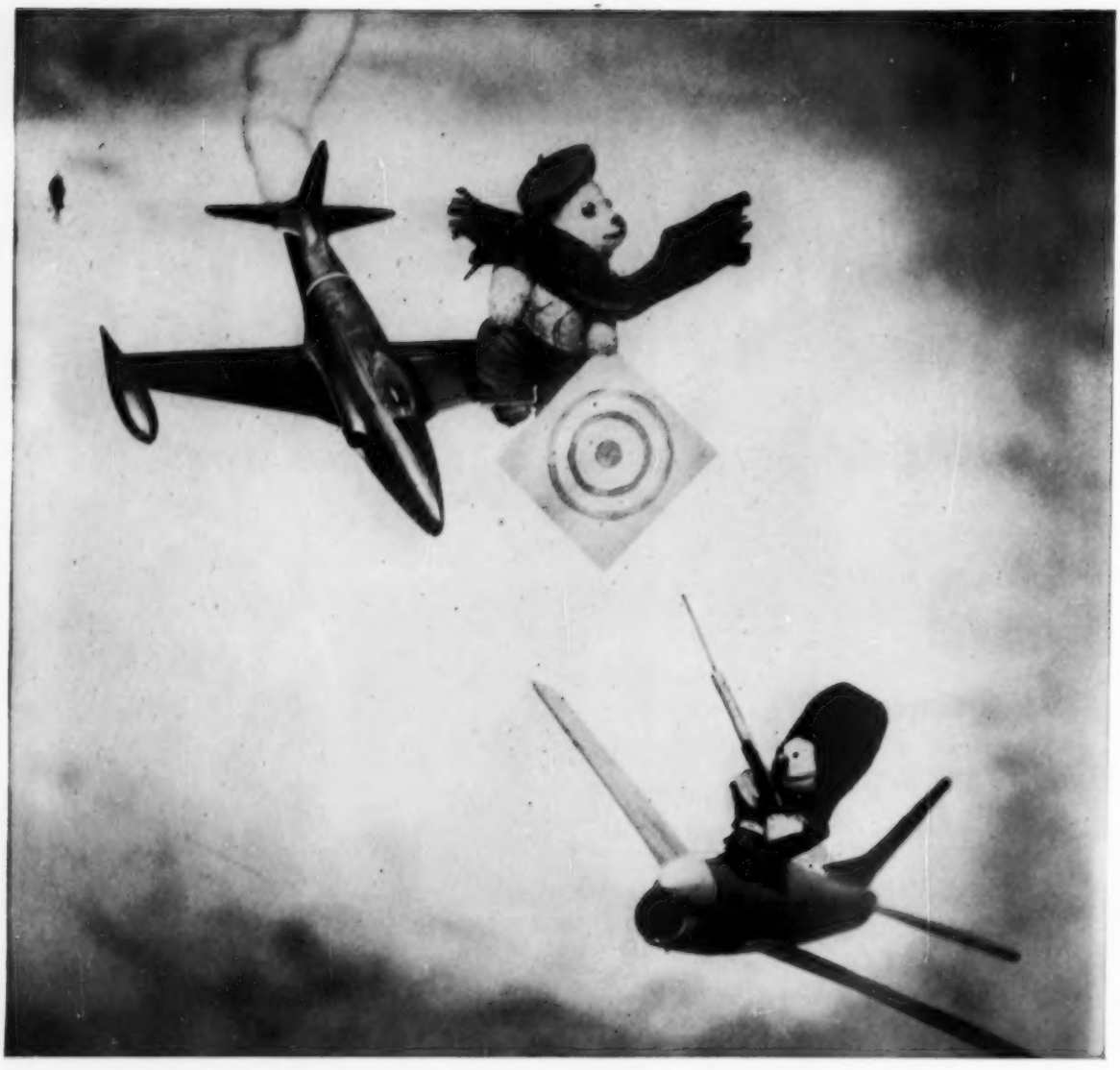
SPECO

THE STEEL PRODUCTS ENGINEERING COMPANY



about weapons systems

. . . AND FORD INSTRUMENT COMPANY

Aiming a gun or a rocket from one plane and hitting another supersonic craft is beyond human capabilities. The elements of speed, ballistics, range, direction, must be taken into account and the aiming point computed in milliseconds.

From its earliest days, Ford Instrument Company has been specializing in weapons systems — ranging from directors and drives for heavy naval guns to rocket launching computers, AA gunfire computers and aircraft weapons systems. Complete familiarity with the military requirements of accuracy, dependability and combat-ruggedness makes Ford-designed and Ford-built instruments among the finest our armed services have at their command.

Ever since 1915, when Hannibal C. Ford built the first gunfire computer for the U. S. Navy, Ford Instrument has been a leader in applying the science of automatic control to American defense and peacetime industry. For more information about Ford's products, services and facilities, write for free illustrated brochure.

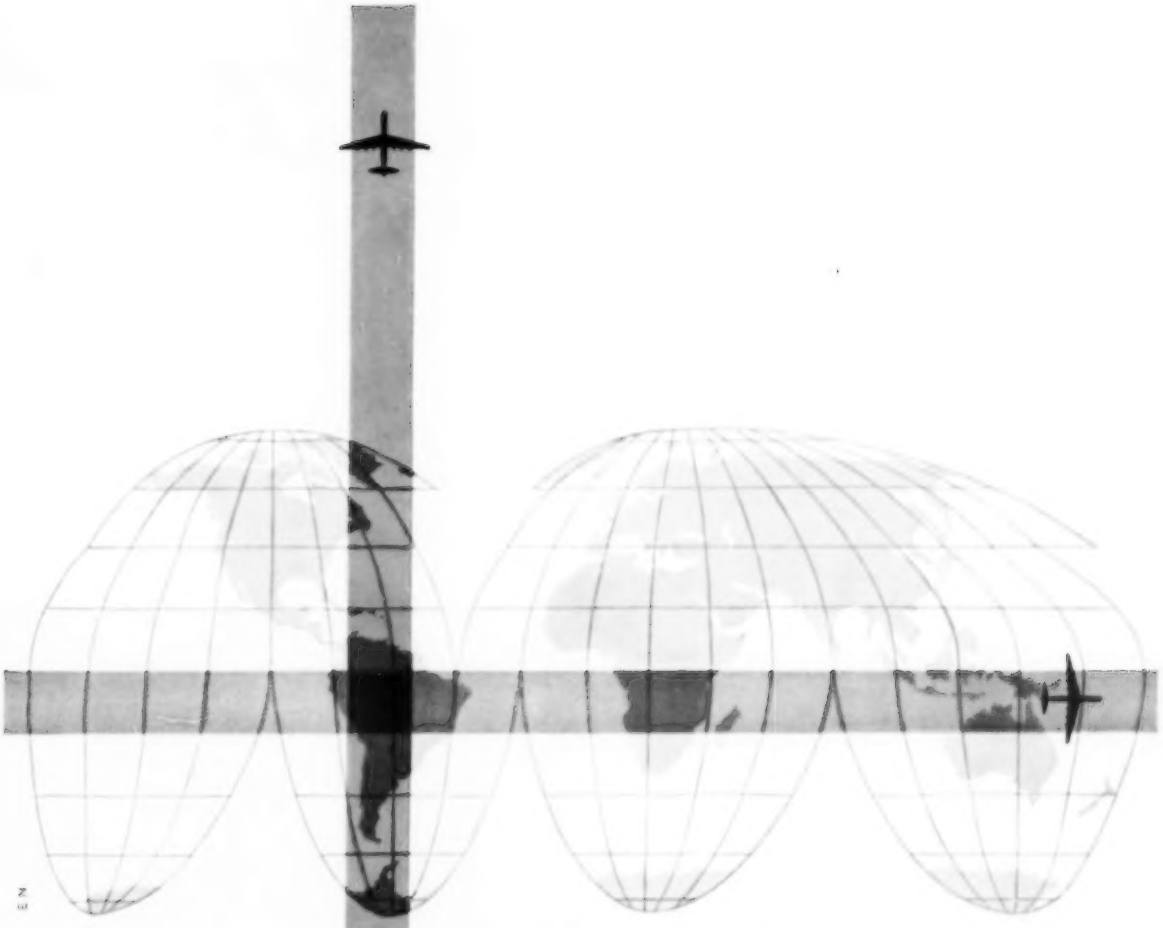
54

FORD INSTRUMENT COMPANY

DIVISION OF SPERRY RAND CORPORATION

31-10 Thomson Avenue, Long Island City 1, New York

ENGINEERS: FORD IS CONSTANTLY ADDING TO ITS STAFF OF ENGINEERS. IF YOU CAN QUALIFY, THERE MAY BE A POSITION FOR YOU.



getting atomic power....off the ground

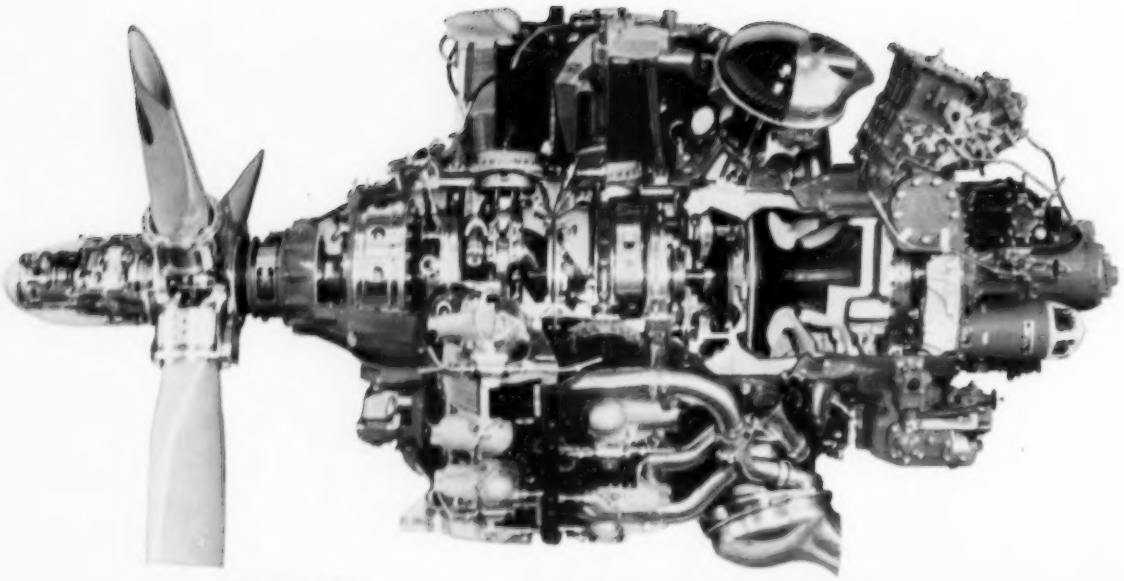
Important in the development of globe-girdling atomic aircraft is the *portable nuclear reactor* built and operated by the Convair Division of General Dynamics for the United States Air Force. Shown, at left, suspended in mid-air for radiation tests, this high-flying reactor is another dramatic example of Dynamics' leadership in the *nucleodynamic* age.

GENERAL DYNAMICS

DIVISIONS

GD | C-L | E-B | G-A | E-D | C-V

GENERAL DYNAMICS CORPORATION • 445 PARK AVENUE, NEW YORK • PLANTS: GROTON, CONN., BAYONNE, N. J., POMONA, SAN DIEGO, CALIF., SAINT LOUIS, MO., FORT WORTH, TEX., MONTREAL, CANADA

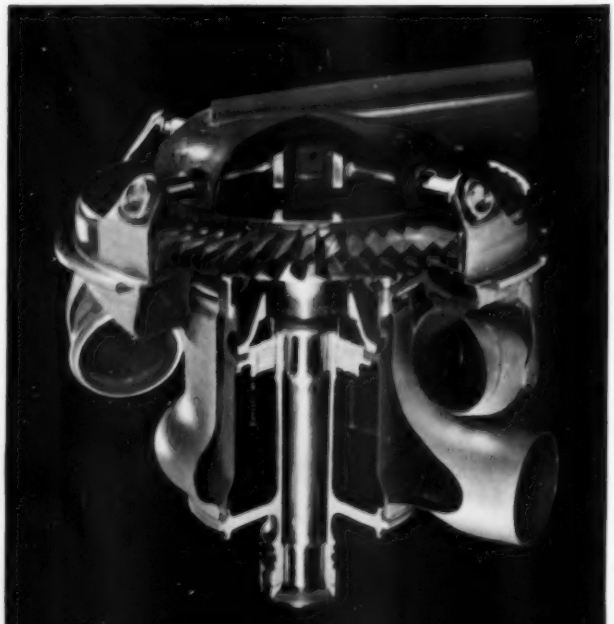


CURTISS-WRIGHT
Turbo Compound Engines are in use by 30 World Airlines plus leading military aircraft

Kelsey-Hayes helps put 20% power bonus into Curtiss-Wright engines

One more example of Kelsey-Hayes diversity at work for major industries throughout America

Any way you translate it — *20% longer range, 20% less fuel, 20% more payload* — power recovery turbines on the Curtiss-Wright Turbo Compound engine mean greater operating economy. The entire power recovery unit — requiring 2000 close tolerance machining operations — is manufactured to highest engineering standards by the Kelsey-Hayes Wheel Company, Detroit 32, Michigan.



CROSS SECTION of the velocity-type, power recovery turbine unit manufactured for Curtiss-Wright by Kelsey-Hayes. The unit consumes no fuel. Exhaust gases are piped directly to the turbine and converted to usable power. There is no harmful back pressure. Effective operation is assured at all speeds and altitudes.

KELSEY HAYES

World's Largest Producer of Automotive Wheels

Wheels, Brakes, Brake Drums, Special Parts for all Industry • 9 Plants — Detroit and Jackson, Mich. . . . McKeesport, Pa. . . . Los Angeles . . . Windsor, Ont., Canada . . . Davenport, Ia. (French & Hecht Farm Implement and Wheel Div.)

DOW

airborne hangar for the Marine Corps

. . . *made of Magnesium*

The U.S. Marine Corps called for a very particular metal for the framework of a very unusual "flying hangar." This metal had to be:

- Light enough to be carried, completely assembled, by a helicopter.
- Strong enough to withstand the repeated takeoffs and landings.

Magnesium, with its high strength/weight ratio, was the answer. Matter of fact, magnesium is appearing in more applications every day where light weight and simplified design are important.

Follow the Marine Corps—take a new look at magnesium! Call your nearest Dow sales office for more information or write to THE DOW CHEMICAL COMPANY, Midland, Michigan, Dept. MA 3131.

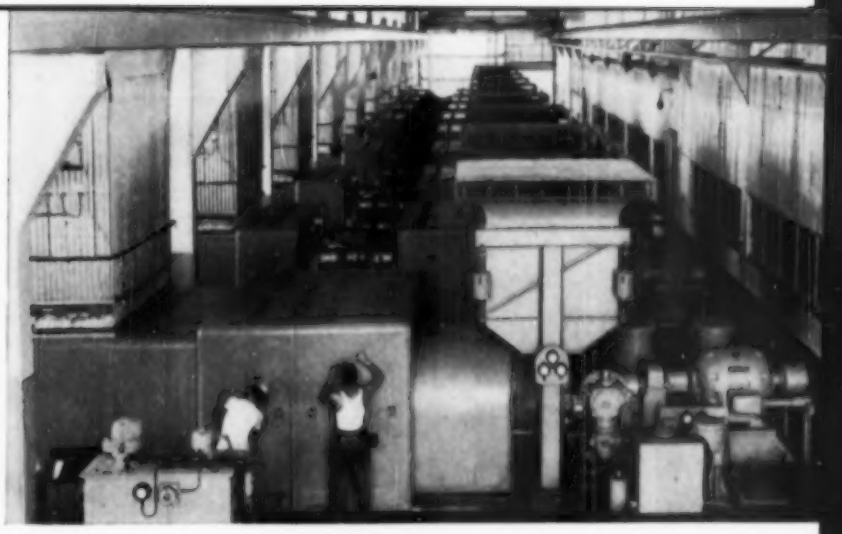
you can depend on DOW MAGNESIUM DOW

CELESTIAL NAVIGATION—Link Aviation's high-speed, high altitude celestial navigation trainer; only such trainer capable of simulating trans-Polar flight. Trains navigators in techniques of guiding planes by the stars.

Vital Controls

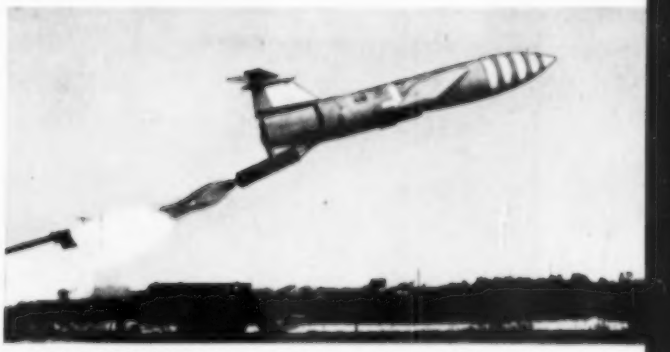
The controls on the world's fastest submarine; the most advanced airborne navigation system known to exist; other similarly advanced military systems and equally advanced industrial equipment and control systems are outstanding examples of the work of the producing companies of General Precision Equipment Corporation. More than a dozen major industries are served by instrumentation and systems designed, developed and produced by GPE Companies.

Ten of the companies in the GPE Group—notably Askania, Kearfott, Librascope and Link Aviation—devote substantial resources to the development and manufacture of instruments, servos and controls. These are used in equipment and systems developed by these companies



PROCESS CONTROL—Askania controls regulate speed of the ten turbines which develop compression to maintain gas suction pressure in Creole Petroleum Corporation's giant, pile-supported oil drilling operation on Lake Maracaibo, Venezuela.

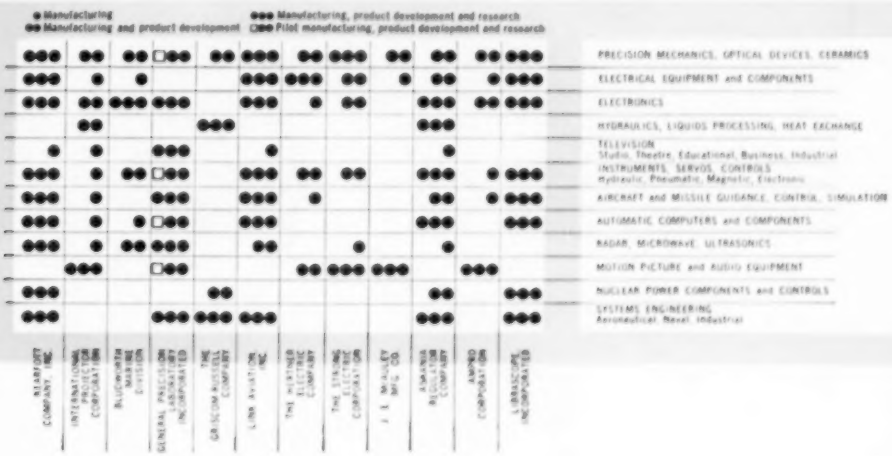
SUBMARINE OPERATION—Controls developed and produced by Askania Regulator Company are utilized to govern operation of U. S. Navy's modern Guppy type submarines.



MISSILE GUIDANCE—One of the many guided missiles equipped with Kearfott basic gyro reference systems, the B-61 Matador—U. S. Air Force's first successful ground-to-ground tactical weapon.

GPE

CAPACITIES



themselves, as well as in systems and equipment developed and produced by other manufacturers of advanced technological equipment.

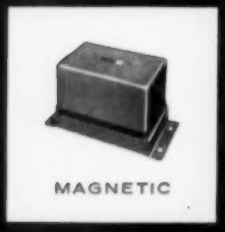
All GPE Producing Companies work in the advanced areas of highly specialized fields and are engaged in the design, development, manufacture and sale of equipment which is closely related from a technical point of view. It is all precision equipment; it derives from similar fields of technical competence; it saves labor, increases productivity or achieves results which cannot be achieved with even limited use of on-the-spot manpower. The chart here shows the specialized fields in which the key GPE Producing Companies work.

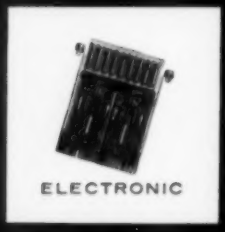
In addition to specialization in its particular products and fields of technical competence, each of these companies has at its command, as required, the facilities and specialized techniques of the other GPE Companies in their respective fields. Interrelation of their resources is achieved through GPE's basic operating policy, GPE Coordinated Precision Technology. In all areas in which GPE Companies work, this coordination has been responsible for a wide variety of precision equipment of superior design and performance, embodying new, advanced principles.

A brochure relative to the work of the GPE Companies and GPE Coordinated Precision Technology is available. Address your request, or specific inquiries, to: GENERAL PRECISION EQUIPMENT CORPORATION — 92 Gold Street, New York 38, N. Y.

TURNING WITH EASE...

from one thing to another





One standard to follow in selecting a designer for your specialized electronic control systems is to choose a firm that builds its *own* components for the control systems it makes. Librascope, Inc. manufactures such diverse electronic components as read-record heads, drums, magnetic amplifiers, flip-flop cards, packaged circuitry, analog-digital converters and other devices for sub-assemblies in its own military and commercial systems packages. This versatility of "turning with ease from one thing to another" indicates a competence for overall systems design acquired through nearly two decades in computer-control manufacture. Such highly specialized experience is available for the solution of your data-handling or computer control project. Inquire today.

Librascope also manufactures mechanical and optical components for computers and controls. Send for booklet describing the company.

Engineers in search of interesting assignments, security, advancement—contact Mac McKeague, Personnel Director.

LIBRASCOPE

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORP.

LIBRASCOPE, INC. • 808 WESTERN AVENUE • GLENDALE • CALIFORNIA

Bottoms Up!

TELEVISION has moved the ocean floor upstairs.

It is now a 'floor show' for technical and executive observers who get a dry but direct view of submerged objects – hulls, shafts, propellers, docks, locks, new designs or tow tests. This advance in seeing the unseeable is made possible by new remotely operated underwater television equipment.

This is but one example of GPL's pioneering efforts in specialized television equipment for any environment or task – industrial or military – under the sea, in the air or on the land. Whether it be television equipment for the broadcasting studio, the industrial plant, the theatre, business telesessions, airborne applications, GPL is ready with a highly qualified television development staff experienced in all these fields.

Again, GPL through research opens new frontiers in military and peacetime worlds.

Engineers: Write for employment data.

GPL

GENERAL PRECISION LABORATORY

Incorporated • Pleasantville, New York

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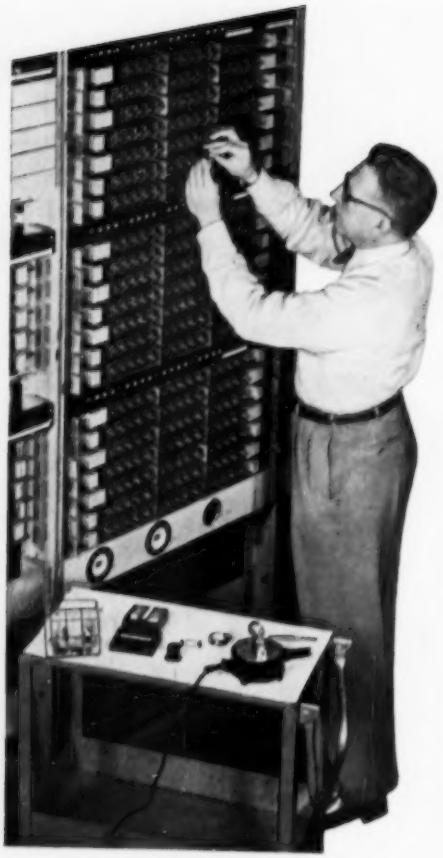


He's "fingerprinting" a relay contact

Bell Laboratories microchemists have perfected an ingenious new technique for "fingerprinting" relay contacts, the tiny switches on which a dial telephone system critically depends.

Using a portable test set, a chemist makes a plastic print of a contact. On-the-spot examination of the print with a microscope and chemical reagents quickly reveals the effects, if any, of arcing, friction, dust or corrosive vapors. While the chemist studies the print, urgently needed contacts continue in service. Findings point the way to improve relay performance.

This is another example of how Bell Telephone Laboratories research helps to keep your telephone system the world's best.

Above, Bell Laboratories microchemist applies plastic disc in heated clamp to relay contact. Imprint reveals contours of surface and picks up contaminants, if any. Part of portable test set is shown on table. Contacts, shown in small sketches, are of precious metal fused to base metal.

Preparing disc for microscopic examination. On-the-spot examination may reveal acid, alkali, sulfur, soot or other polluting agents peculiar to an area.

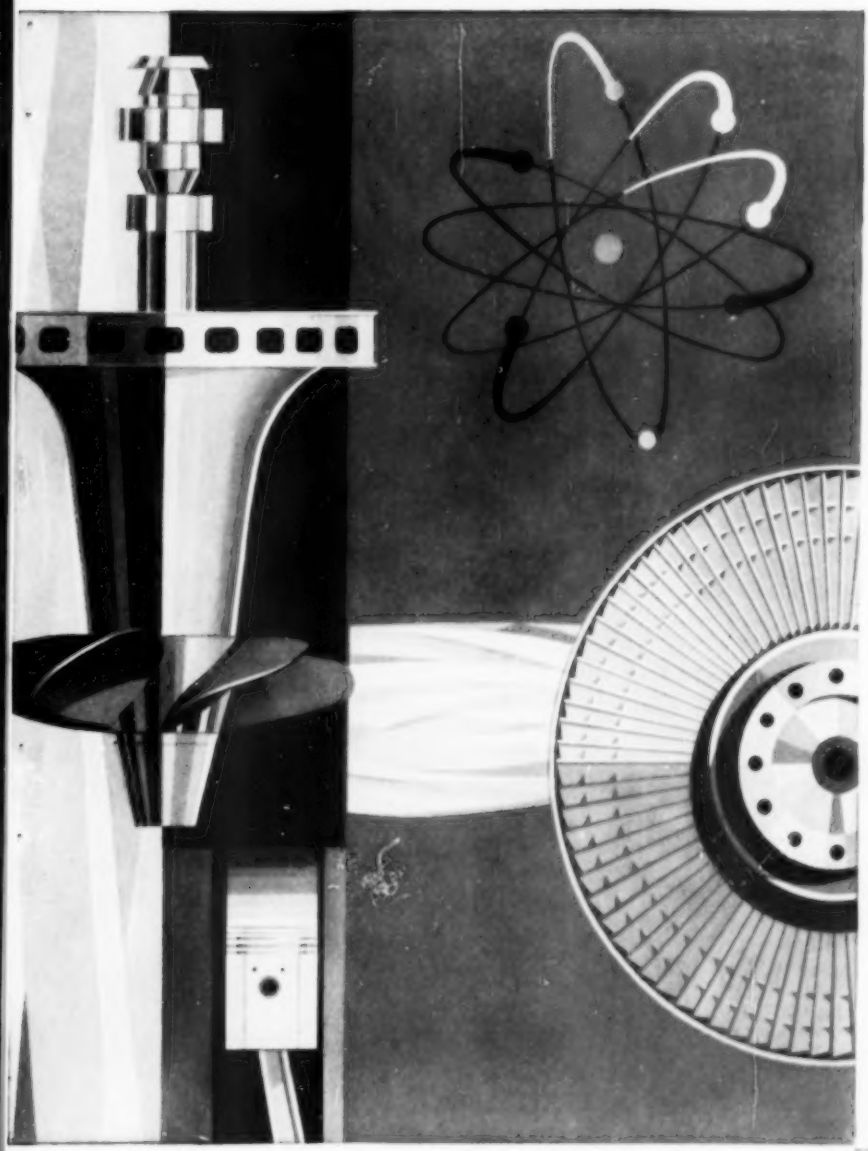
A microscopic look at disc often provides lead to nature of trouble. Unlike actual contact, print can be examined with transmitted light and high magnification.

Here the plastic disc has picked up microscopic lint that insulates contact, stops current. (Picture enlarged 200 times.) Traces of contaminants are identified in microgram quantities. Inert plastic resists test chemicals that would damage contact.

Bell Telephone Laboratories

Improving telephone service for America provides careers for creative men in scientific and technical fields

Symbols of Progress



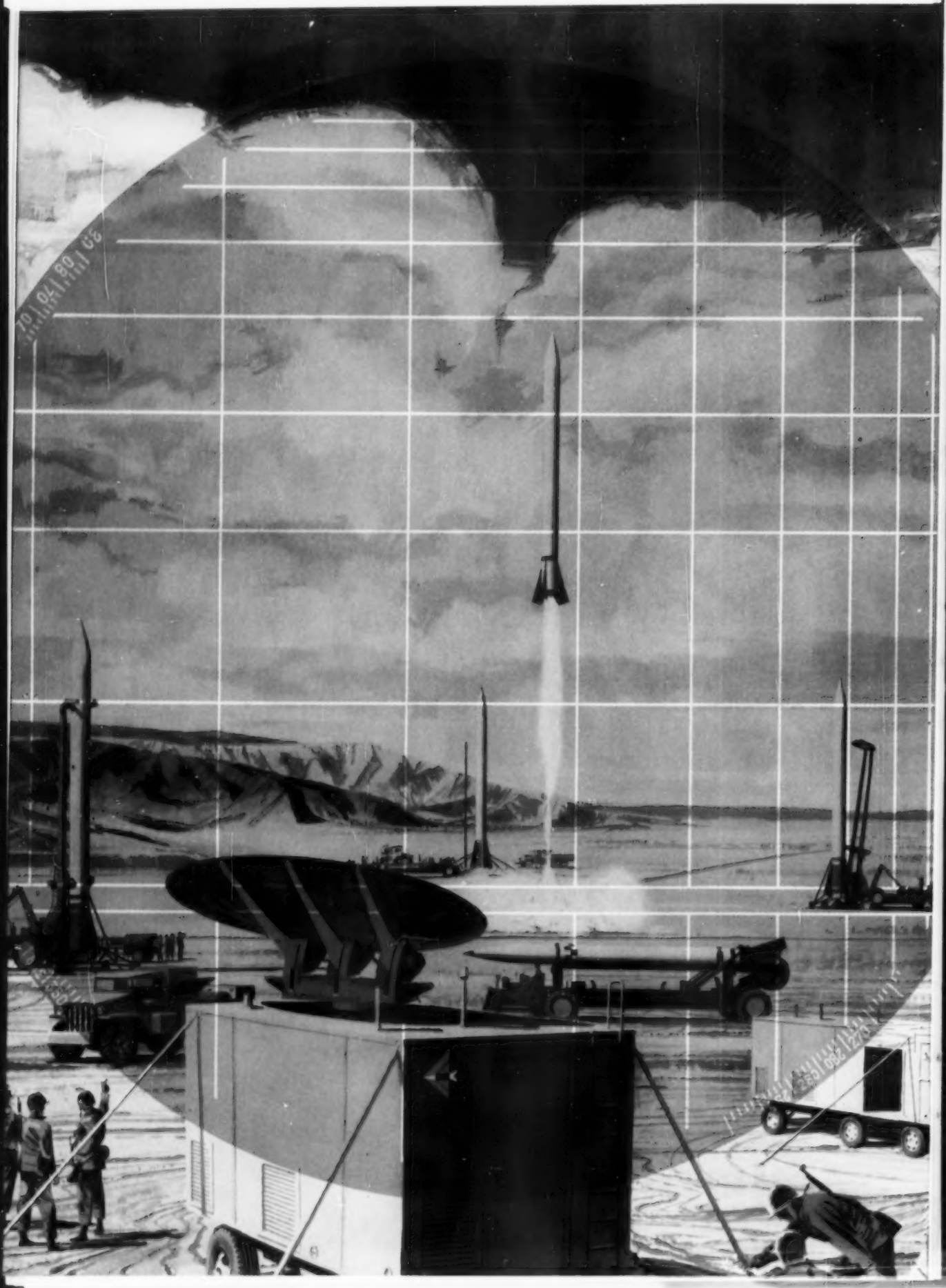
These major forms of power are the building blocks of progress. Power from rushing water, put to work by hydroelectric plants . . . from superheated steam, spinning thousands of turbine blades . . . from petroleum, through internal combustion engines . . . and now from the atom itself.

In the future as in the past, Allis-Chalmers is dedicated to leadership in power for better living . . . whatever the source of energy.

Here is the power that breaks ground for progress. Big Allis-Chalmers diesel-powered earth movers carve out road beds, level land for airports and home sites. They are the pioneer tools of construction in both civilian and military use.

ALLIS-CHALMERS

TRACTOR DIVISION • MILWAUKEE 1, U. S. A.



GUIDING THE "CORPORAL"

ELECTRONIC GUIDANCE IS THE SECRET OF THE CORPORAL'S ACCURACY

The U. S. Army required a ground-to-ground missile capable of delivering an atomic warhead at supersonic speed — accurately–to a target beyond the range of artillery. Army Ordnance awarded four prime contracts for this project:

PRIME CONTRACT–RESEARCH
Jet Propulsion Laboratory, California Institute of Technology
Basic research and development covering all facets of total problem.

PRIME CONTRACT–DEVELOPMENT
Gilfillan Bros., Inc.
Improvement, simplification of ground and airborne electronic equipment.

PRIME CONTRACT–PRODUCTION: MISSILE
Firestone Tire & Rubber Co.
Missile and missile handling equipments.

PRIME CONTRACT–PRODUCTION: GROUND GUIDANCE SYSTEM
Gilfillan Bros., Inc.
Complete ground guidance system.

RESULT: *The Army's "Corporal," ground and airborne equipment. In full production; delivery being made to troops.*

Today's missiles are superior to yesterday's mechanically timed rockets for one reason—electronic *guidance.*

It is electronics research and the electronics industry that put the guidance into the guided missiles . . . that share the major responsibility of keeping America first in guided missiles.

Primary credit for the "Corporal" is due to the basic research achievements of the engineers and scientists of the Jet Propulsion Laboratory at the California Institute of Technology. Gilfillan is proud to have been awarded a prime contract to assist in the development and do the production of the vital electronic guidance system.

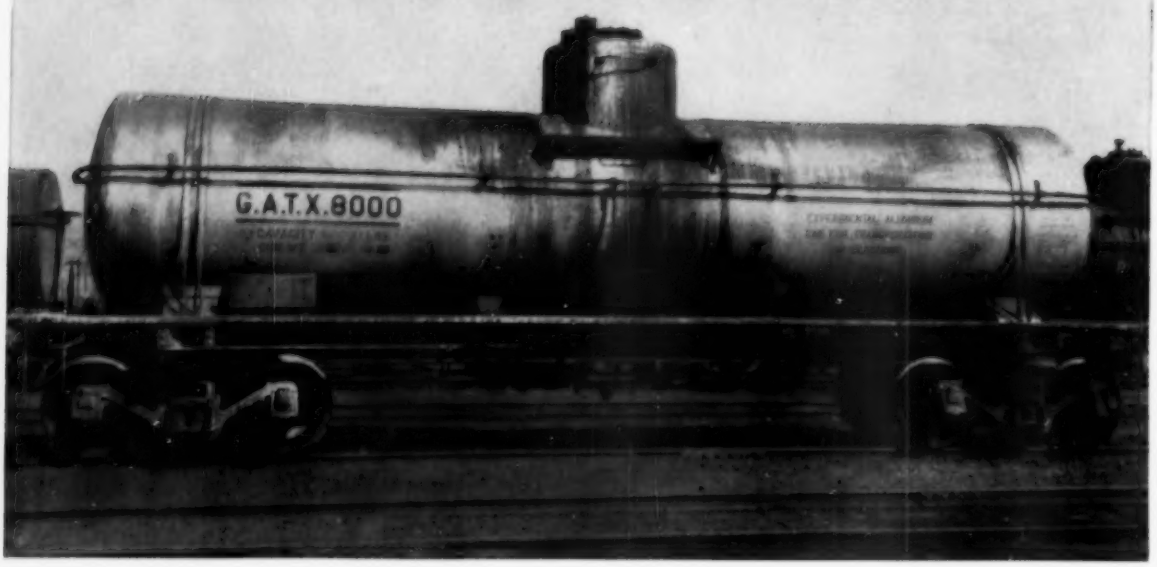
In the electronics industry, Gilfillan is a recognized leader. Gilfillan's ability to carry on from basic research comprehensively—to approach a total problem as a whole and achieve a whole solution—has been thoroughly proven in GCA Radar, the "Corporal" guidance system, and is now being further demonstrated in top secret projects in a number of fields.

Today and Tomorrow
Comprehensive Research and Development

GCA RADAR AND ELECTRONICS
Gilfillan
LOS ANGELES
GCA
AROUND THE WORLD

THEY MADE HISTORY!

This car, and the men who designed it



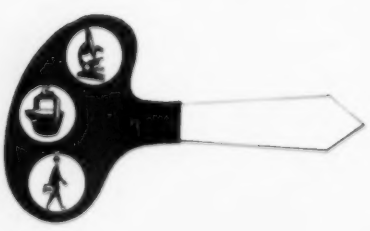
Back in 1928, Alcoa engineers pointed out the advantages that aluminum would bring to railroad tank cars carrying hard to hold chemicals, easily contaminated foods. So Alcoa designed and undertook to pay for the first aluminum tank car. The car builder and a shipper became interested. On completion of the car, the builder assumed the cost and leased it to the shipper for regular service.

Interest in aluminum tank cars increased. Impact recorders and strain gages gave the designers new data. The aluminum production men rolled the heaviest plate, made the largest rivets produced up to that time. The second car was made from 8 instead of 16 plates. Joining time cut in half!

Today three plates, plus heads, joined by newly developed welding methods make an aluminum tank car. And 2,000 of them, including the first one ever made, are in service.

Another instance where Alcoa engineering and co-operation have brought the advantages of aluminum to a new application. The same research, test and development facilities stand ready to help you make the best possible use of aluminum. ALUMINUM COMPANY OF AMERICA, 850-G Alcoa Building, Mellon Square, Pittsburgh 19, Pa.

Your Guide to Aluminum Value



tic 'tac' toe!

In the event of surprise attack, today's new and more powerful USAF Tactical Air Command can now carry war to the enemy anywhere in the world—around the clock and in any weather.

Here at a glance are some of the elements that might be used in such an attack and which are contributing to Tac Air's new mobility and striking power.

In modern warfare, major fixed bases are certain to become targets for initial enemy action. The Martin zero-length launcher makes possible swift mobility and advance-area operation of the TM-61 Matador tactical missile and—if need be—of piloted jet fighters.

In addition, new versions of U.S. Air Force's B-57 bomber, a major tactical weapon, are now being developed for service.

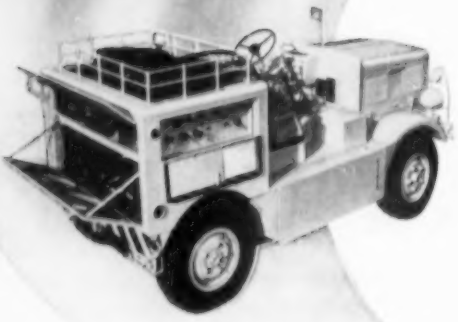
And for tomorrow's Tactical Air Command arsenal, new and more powerful Martin weapons systems are on the way.

MARTIN

BALTIMORE · MARYLAND

minute men

WHEN SECONDS MEAN SURVIVAL, ground support equipment of unquestionable reliability is the indispensable factor. As a pioneer in all phases of ground support, CONSOLIDATED has developed units of broad application for maintaining missiles or piloted aircraft at a constant ready. Through design, development and manufacture, we have solved the most complex problems of providing self-propelled, multi-purpose units . . for towing, testing, servicing and starting guided missiles and jet aircraft . . . . . quickly, surely and under the most difficult operational conditions. Several of CONSOLIDATED's models are now being used extensively by the U. S. Air Force, Navy and Marines.

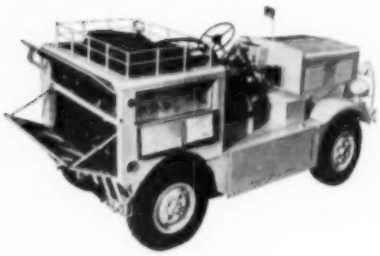


MODEL 2100 INCORPORATES HYDRAULIC, A. C., D. C. ELECTRIC, AND TOWING.

IN THE EXACTING FIELD OF GROUND SUPPORT, CONSOLIDATED HAS DEMONSTRATED ITS ABILITY TO MEET THE MOST COMPLEX DEMANDS

CONSOLIDATED
DIESEL ELECTRIC CORPORATION

STAMFORD, CONN. BRANCHES · DALLAS, TEX. · DAYTON, OHIO · SANTA ANA, CAL. · WASHINGTON, D. C.



Model 2100,

GROUND SUPPORT

This compact self-propelled multi-purpose unit, Model 2100, performs all requirements of electrical, hydraulic, and pneumatic testing and servicing of guided missiles . . . and can be used for heavy duty towing. It provides:

- HYDRAULICS . . . 10 gpn, 3000 psi variable volume, pressure compensating.
- A.C. POWER . . . . 30 KVA, 400 cycles, 3 phase and 10 KVA single phase, close regulated.
- D.C. POWER . . . 28.5 volts, 500 amp continuous.
- TOWING . . . All wheel drive, over 5000 lb. drawbar pull.

Other models of single and multi-purpose Ground Support equipment are available with hydraulic systems . . . any combination of A.C. and D.C. power . . . high and low pressure pneumatic systems . . . refrigeration and heating.

CONSOLIDATED
DIESEL ELECTRIC CORP.
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ATOMIC ENERGY

POWER REACTOR PROGRAM

Four proposals have been made by public and private organizations under the AEC's power demonstration reactor program. The four proposed power plants would have a total of 455,000 kilowatts of electrical capacity. Taking the proposals as a group, the estimated capital cost of the four plants would be about $150,000,000 of which 80 to 90 per cent would be borne by the proposers.

Any of the four proposals qualifying under the established criteria will be considered on a competitive basis within the limits of the funds and materials that may be available to the Commission for this program. Obligational authority of $75 million for general acceleration of the civilian power program has been included in the AEC budget request for fiscal year 1956. To carry on their projects, successful proposers must qualify as licensees under the provisions of the Atomic Energy Act of 1954. The proposals received are for:

1. A boiling-water reactor plant of 180,000-kilowatt capacity to be completed in 1960.

2. A light water moderated and cooled reactor plant of 100,000-kilowatt capacity, to be completed in late 1957.

3. A fast breeder reactor plant with 100,000-kilowatt capacity, to be completed in late 1958.

4. A sodium graphite reactor plant of 75,000-kilowatt capacity, to be completed in 1959.

In addition to the power-reactor projects contemplated in the proposals under the power demonstration reactor program, the Consolidated Edison Company of New York has applied to the AEC for a license to build and operate entirely with private capital a nuclear power plant with a capacity of 250,000 kilowatts which the company estimates will cost about $55,000,000.

The reactor for this plant would be light water cooled and moderated and would take about five years to build. This plant, combined with the other four proposals, would total 705,000 kilowatts of installed electric capacity, costing about $205,000,000.

Under the power demonstration reactor program the AEC announced last January it would consider giving the following kinds of cooperation and assistance:

1. Waiving the established commission charges for loan of source and special nuclear materials up to an agreed-upon amount for a period of up to seven years from July 1, 1955. However, the licensees will be required to pay for materials consumed in the demonstration project and for services performed for them by AEC, such as recovery of materials from spent fuel elements.

2. Performing in AEC laboratories without charge to the licensees certain mutually agreed upon research and development work.

3. Entering into research and development contracts under Section 31a of the Atomic Energy Act of 1954 for the technical and economic information resulting from development, construction, and operation of power demonstration reactors by contractors. The amounts to be paid by AEC under the contracts will be fixed in advance and may be used for development, fabrication, and experimental operation.

Information derived from operations under the contracts will be made available by AEC to the maximum extent practicable to the entire technical public working on reactor development, with resultant benefit to the progress of the entire nuclear power program.

NEW ISOTOPE POLICY

The United States Atomic Energy Commission will make radioisotopes for all biomedical and agricultural research and research in medical therapy available to domestic users at twenty per cent of the catalog price effective July 1, 1955.

Since 1948 the Commission has subsidized the distribution of radioisotopes used in cancer research and therapy. Initially, radioisotopes for use against cancer were made available without charge for production costs. Since 1952 a charge of twenty per cent of the catalog price has been made.

Under the new policy, reduced prices heretofore available only for cancer will be extended to all biomedical and agricultural research. The discount will not be available for radioisotopes used for routine clinical treatment.

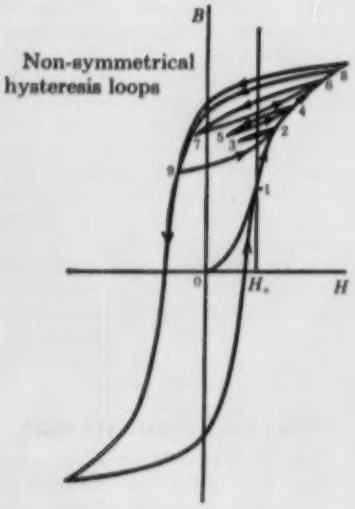
NUCLEAR INFORMATION

A new program under which organizations or individuals may be given access to nonmilitary confidential and secret restricted data on atomic-energy technology for their own private purposes was recently announced by the Atomic Energy Commission.

The program simplifies and replaces the provisional industrial participation program which made classified restricted data in the field of reactor technology available under three distinct types of agreements.

Under the new program, nonmilitary information which is classified as "confi-

Write for notes on magnetic core design for audio transformers and filter reactors



Non-symmetrical hysteresis loops

■ Close performance specifications depend, of course, on methods of core design and testing procedure. We have prepared organized engineering data presenting incremental permeability as applied to audio transformer cores which will provide you with valuable reference material. Ask for Bulletin A8.

■ Magnetic Metals Company has pioneered mass production of magnetic core units to each individual requirement. Nothing new about these features in Magnetic Metals Company's long established prompt and reliable service.

electromagnetic cores and shields

MAGNETIC METALS COMPANY

HAYES AVENUE AT 21st ST. • CAMDEN 1, N. J.

dential, restricted data," may be made available to any person who can evidence a potential use or application of the information in his business, profession, or trade. The other conditions to this access are that the applicant obtain a simplified security ("L") clearance and agree in writing to conform to all AEC security regulations.

Under similar conditions, limited access may also be granted to certain specific information, classified as "secret, restricted data," if the applicant can demonstrate that such information has an immediate and significant effect on his business, profession, or trade. However, in this case the applicant must obtain a full security ("Q") clearance, and the Government will retain royalty-free nonexclusive rights for governmental purposes in inventions and discoveries which result from such access.

ATOMIC-POWERED ENGINE

An agreement has been signed by the Atomic Energy Commission, the Baldwin-Lima-Hamilton Corporation of Philadelphia, Pa., and the Denver and Rio Grande Railroad of Denver, Colo., for a study of a nuclear-powered reciprocating engine under the AEC's industrial participation program.

The companies will weigh the engineering, technical, and economical aspects of a nuclear-powered engine of this type and make recommendations concerning the rôle industry might undertake in carrying out the development. There are many potential applications of a power-generating unit of the type under study, including locomotive propulsion.

The AEC will make available to cleared personnel of the group the technical information already developed which is applicable to the study and will provide consultation services of its personnel and of contractor personnel as required. The study will be for a one-year period and will be financed entirely by the companies participating in the program.

NUCLEAR BATTERY

A nuclear battery that converts nuclear energy into electrical energy has been developed by the Patterson-Moos Research Division of the Universal Winding Company.

Said to be capable of performing under temperature conditions ranging from minus 60 to plus 160 degrees Fahrenheit, the battery has an operating life in excess of 25 years. Three models are available with voltage and current ratings ranging from 1 to 10,000 volts and 5 to 2,000 micromicroamperes.

The disintegration of strontium 90 is used as the energy source, and the company states that the external radiation of the battery is within the Atomic Energy Commission tolerance limits.

AMERICAN ORDNANCE ASSOCIATION

Founded 1919

A patriotic, educational, scientific, nonpolitical, and nonprofit-making organization of American citizens dedicated to scientific and industrial preparedness for the common defense

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GEN. MAXWELL D. TAYLOR
Chief of Staff, United States Army

The Military Profession

Patriotic dedication to duty is the mark of the career serviceman

THERE is a world of difference between a vocation and an avocation. The first is a lifetime dedication to a particular profession or occupation because of personal preference and aptitude; the second is a part-time hobby, a seasonal distraction, a minor employment.

As a general observation it may be said that a dilettante, an amateur, a smatterer, a Jack-of-all-trades rarely achieves distinction in any single field. The reason, of course, is that the full mastery of any profession demands a lifetime of unselfish and persistent toil and effort.

These reflections are particularly true in the military field. No effective national-defense system can be either established or successfully maintained by part-time, once-in-a-while soldiers. And no series of temporary enlistments can possibly give our Nation the type of national-defense program, reaching out to the uttermost ends of the earth, that is imperative in these uncertain and perilous times.

QUITE recently a change of command has taken place in our Army. Gen. Matthew B. Ridgway, a life-long professional soldier, has been succeeded as Chief of Staff of the Army by Gen. Maxwell D. Taylor, a veteran of thirty-seven years of uninterrupted professional service to his country.

Both men have the qualities of greatness. Both are battle-tested military leaders of demonstrated courage, vision, and unusual competence. Both typify the military profession at its best.

How fortunate are we that a change in command does not represent the slightest deterioration in the strength and morale of our military structure; that heavy and difficult command responsibilities can be transferred without the least misgiving; that our training system is fundamentally sound; and that our free American way of life provides both the opportunities and the incentives for all our youth to prepare themselves for the highest posts and positions in fields of their own choosing.

A word of special commendation is certainly due to our great service academies—West Point, Annapolis, Colorado Springs. The American people set up these fine academic institutions and both our faith and our unwavering patriotism have been amply justified in the products of these academies—the long lines of stalwart young men who carry forward, generation after generation, a great tradition of professional service to country in a way that merits the pride and gratitude of free people everywhere.

OUR professional military leaders are a priceless asset to our country. In an age of remarkable technological advances, they represent the imponderable human factors—leadership, wisdom, courage—the deep-rooted qualities of heart and mind that give direction and purpose to a mighty military machine.

In these days of atomic weapons, international tensions, and cold war, it is comforting to know that there is a strong core of dedicated leadership in our Army, Navy, and Air Force—men whose patriotic devotion to God and country is sometimes passed over lightly in peacetime but in war is the bulwark of our defense. Love of country is the gage of victory when the chips are down.

All of us can be certain that General Taylor will inspire a nucleus of military strength in our Nation that will give pause to an enemy and a confident sense of security to our own people.

Gen. Maxwell D. Taylor, newly appointed Chief of Staff of the Army, whose photograph appears on the opposite page, was graduated from the United States Military Academy in 1922 and was commissioned in the Corps of Engineers.

In July 1941, General Taylor was on duty with the General Staff and later was transferred to be chief of staff of the 82nd Infantry Division at Camp Claiborne, La. In the latter capacity he personally assisted in the development of the first airborne divisions of our Army and then became artillery commander of the 82nd Airborne with which he took part in the Sicilian and Italian campaigns.

In his "Crusade in Europe," President Eisenhower records General Taylor's mission to Rome in 1943. He was sent there by British PT boat and Italian corvette through enemy lines twenty-four hours ahead of the planned airborne invasion of Italy to confer with leading Italian authorities.

In September 1945 he returned to this country to become Superintendent of the United States Military Academy at West Point. Four years later he became chief of staff of the European Command, then the first American commander in Berlin.

From 1951 to 1953 General Taylor was Deputy Chief of Staff for operations and administration. He succeeded Gen. James A. Van Fleet as commander of the Eighth Army in Korea and, under him, that force engaged in some of the bitterest fighting of the Korean war.

Last November General Taylor was placed in command of all ground forces in Japan, Okinawa, and Korea when he took over the combined staffs of the Army in the Far East and the Eighth Army headquarters at Camp Zama, Japan.

He assumed his present duties as Chief of Staff of the Army on July 1, 1955. He is a life member of the American Ordnance Association.

Naval Preparedness

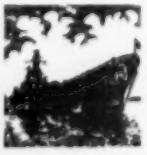
The Navy is keeping abreast of the enormous technological advances in armament and equipment in order to increase its striking power and mobility and maintain control of the seas for national defense

Vice Adm. F. S. Low

MOST of us are prone to forget quickly. We are hemmed in by our modern, crowded, daily lives with little time for reflection or appreciation of the vast changes that have characterized these recent years.

Those of us who have experienced more or less of the last fifty years, have been a part of the most rapid and most significant changes in the history of our country—and perhaps all history. By far the greatest proportion of this evolution has been packed into the last decade. What has happened during this period is almost incomprehensible, and the effect on the Department of Defense has been to create the greatest conceivable challenge.

A little over ten years ago France had been liberated and the Allied armies were driving east into Germany; General Hodge's First Army had crossed the Marne, to be followed shortly by the famous Third Army under General Patton. On May 7, 1945, Germany surrendered.



We were still at war with Japan, but the end was in sight. Our power in the Pacific was at its peak; the Pacific Fleet covered most of that ocean. Iwo Jima had fallen to the Marines.

Two years ago President Eisenhower had assumed the office of President, and Charles E. Wilson had been confirmed as Secretary of Defense. He had named a committee headed by Nelson Rockefeller to investigate and advise on the organization of the Department of Defense. That committee interviewed many distinguished persons, military and civilian, and reported in April 1953.

Admiral Low is Commander of the Western Sea Frontier and Commander of the U. S. Pacific Reserve Fleet. This address was delivered at the Thirty-seventh Annual Dinner of the American Ordnance Association held in the Hotel Fairmont, San Francisco, Calif., May 10, 1955.

The President sent his recommendations to the Congress in the form of Reorganization Plan No. 6. In the absence of congressional action, Plan 6 became effective on June 29, 1953.

Many of you know the details of the development of the Department of Defense organization and its workings. I should like to concentrate on certain aspects of one of its branches—the Department of the Navy. Before doing so, however, I should like to point out that these historic events which I have cited—from Iwo Jima to the Rockefeller Committee Report—span only eight years.

The Rockefeller Committee recommended the addition of certain Assistant Secretaries in a variety of policy fields, and these offices were established. Next, there occurred a rewriting of what is known as the Key West Agreement, which outlined the functions and powers of the three military services under the Department of Defense.

This resulted in a redefinition of the rôles to be played by the Joint Chiefs of Staff and a redefined concept of the relationship of the Departments to this important body. Finally, detailed studies of each of the military services were conducted.

It is quite clear that the rôle of the Office of the Secretary of Defense and his Assistant Secretaries should be one of policy guidance and coördination. It is quite clear, too, that this concept has added, far more than most appreciate, to the responsibilities of the service Secretaries.

IN the Naval organization we have a dual concept which was devised and instituted by Secretary Forrestal and stood the test of World War II. It divides the Navy between the purely military or operational side and the business or production side.

This organizational concept is the result of the Forrestal pattern and of efforts made by many persons over recent years—and it works well. It is a different organization from the General Staff concept used in both the Army and the Air Force.

The business side of the naval organization is under adequate civilian control and is now in the process of implementing certain improvements to

increase its effectiveness. A good base has been established, and the Navy is prepared to shoulder the responsibility if it does not do things as it should. Policy, management, and control have been assigned to each Secretary.

This business side of the Navy regards the operating forces, which function under the Chief of Naval Operations and the Commandant of the Marine Corps, as its customers. It produces their requirements. To accomplish this, it is responsible for the efficient management of the vast shore establishment.

This shore establishment includes two million acres of land and encompasses an area larger than that of Delaware and Rhode Island combined. It has a value in the neighborhood of seven billion dollars. It includes material and stores on hand with a value of approximately thirteen billion dollars.

AS a result of the Navy's examination of its organization, there have been added two new Assistant Secretaries. One is in charge of the financial management of the Navy and serves as its comptroller. The other devotes his full time to the varied and difficult problems dealing with manpower, personnel, and reserves.

Thus our other two Assistant Secretaries are able to devote their time and direction to the equally important fields of material and air and research and development.

Finally, the responsibilities of the Secretary of the Navy and the Under Secretary of the Navy have been defined more clearly and strengthened.

An opportunity for service exists which industry as a whole should, but apparently does not always fully appreciate. Your membership and interest in the American Ordnance Association is a concrete contribution to our Nation's preparedness and a sure sign of appreciation of the magnitude and seriousness of the problem.

We are faced with long years of partial mobilization and a high degree of readiness. We are also faced with the necessity of maintaining a sound economy, for there can be no military strength without financial solvency. A worldwide Soviet conspiracy, backed by the weight of Soviet military power, dominates all other considerations of our time.

For its part in carrying out the national policies, the Navy is far-flung across the world. In the event of war our mission will be primarily to control the seas and to extend our military power across the seas. We do not want to fight a war on our homeland. This means ensuring that we have free use of the seas. Those who would destroy us do not have that freedom.

However, the seas are no longer the protective barriers we formerly knew but rather are now the broad highways of world commerce which can be controlled only by the strong. The seas now include the air above and the waters beneath the surface. We are working constantly on the development of new weapons, on modernized and new aircraft carriers, and we have always ready the Marine Corps with its three divisions and three air wings for amphibious assault.

Within the last few years two improvements have been made which, in effect, have provided a face lifting for aircraft carriers.

ONE is the steam catapult which is incomparably better than any we have had before. The other is the "angled deck" which allows aircraft to land at a small angle from the center line of the ship, thus obviating the costly barrier crashes of the past. I think we should be duly humble when we reflect that these were not invented here but are of British origin.

The Navy must maintain massive striking power and great mobility. This is not only a fundamental requirement but also is in consonance with the rôle of the Navy established by the President and the National Security Council.

If we are to maintain our wide and

Newest addition to the Navy's arsenal is the recently launched NAUTILUS, the world's first atomic submarine (Navy photo).

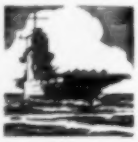
varied commitments, every detail of our fleet and our shore establishment must be continuously screened to eliminate wherever possible and strengthen where necessary. Typical of this is our build-up in new weapons and the shelving or disposal of obsolete ones.

Here, a fine balance must be struck to ensure that we do not denude ourselves of useful and vital weapons before the newer ones have proved themselves.

From time immemorial, control of the seas has been exercised by naval ships employing bows and arrows, guns, torpedoes, airplanes, or whatever was the latest development of the day. With our healthy and forward-looking research and development program in the Navy and with the continued full support of industry, I am confident the Nation may be assured that we will have the current weapon for the current situation.

WE are moving into complex weapons systems—modernizations of great magnitude and urgency. It is the Navy's hope that industry will apply the same ingenuity and energy to the development, production, and delivery of components as it did when it helped us break through scientific barriers and perfect these new systems.

It is no news to you of industry that one computer and its radar system undelivered to its destination can mean great delay in the operational readiness of a modern, all-weather fighter for which the taxpayers of this country have paid approximately one million dollars and which is sorely needed in the fleet.



You will recall, especially those of you who were involved at the time, that in World War II the U-boat menace in the Atlantic was not in hand until mid-1943. For this, we had to wait for science and industry to make their contributions. In round numbers, these contributions amounted to an expenditure of between $40 and $50 billion.

Translated into ships and airplanes, with the most modern equipment and men, this amounted to 1,000 ships, 1,000 aircraft, and 500,000 men—a force which could not have successfully completed the job without your important contributions.

We in the Navy are making progress and are abreast of the great technological advances and the enormous implications and new environments which always accompany such advances. However, there is much, much more to do and room for improvement on some of the things we have done. We need your help.

Procurement procedures require tightening and toughening, and contracts, bidding, and procedures for negotiation must be overhauled. The Navy has to justify its results, plan correctly, and coldly appraise its true state of readiness. In so far as my own service is concerned, nothing is beneficial to national preparedness until it reaches the fleet.

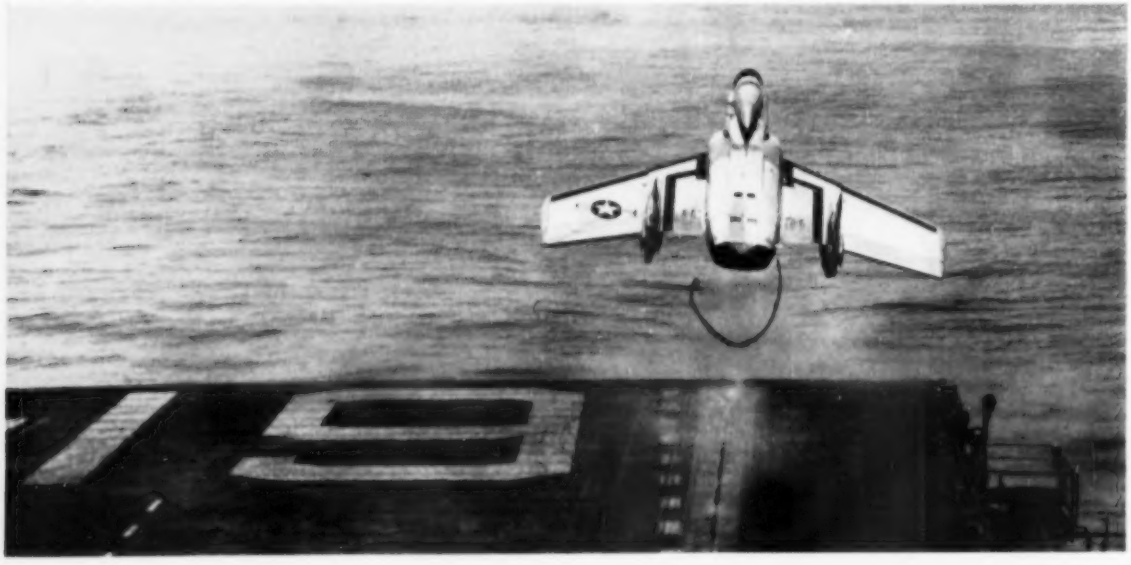
WE must subject this entire area—research, development, production and delivery—to intense scrutiny. Any possibility of error which will impair or delay preparedness must be eliminated. More than ever before, we need facts and accurate forecasts.

Frank opinions—the truth—are essential. We want to know whether our own procedures contribute to delay or confuse industry. Suggestions and cooperation are vital and will be appreciated by the Navy.

Industry is now operating in a healthy climate with satisfactory profits and a high return on invested capital. Now is the opportune moment to strengthen further that mutual understanding and close relationship which contributed so much to our success in World War II and without which we could not be successful in any war.

EDITOR'S NOTE.—This issue of ORDNANCE contains all the addresses and papers given at the Thirty-seventh Annual Meeting of the A.O.A. at San Francisco on May 10, 1955.

Dropping its launching bridle, an F7U-3 soars off the HANCOCK before reaching the end of its steam catapult run (Navy photo).



Industry and New Weapons

The organization that develops the design of a complex new armament item should also be responsible for its initial production to get the best combination of performance, producibility, and low cost

William H. Martin

THE participation of industry in the defense activities of this country is extensive in character and enormous in quantity. Our industrial capacity for producing war matériel has twice exceeded the expectations of both our enemies and ourselves. However, rather than this astounding might and its application in providing facilities for mobilization, I wish to discuss industry's part in developing, getting into production, and making available for service the new complex weapons.

These are the weapons upon which we are depending to give this Nation and its allies the superlative military strength that we hope will discourage the attack that would call for its use.

This participation of industry is a most important factor in ensuring the suitability of military equipment for production in wartime and for its effective use under combat conditions. This participation must be properly directed now in order to afford maximum effectiveness to our industrial and military resources in mobilization.

OUR military position today is based on pushing technology to reveal new potentialities and in keeping our new weapons abreast of these advances. We are in a race which we cannot afford to lose.

To call this a race, however, makes it too simple. A race implies a defined course and goal. Our technological problem is rather one of assuring an unmatched rate of penetration into the vast peripheral fields outside our present areas of knowledge. The planning and implementation of this penetration challenge the combined scientific, engineering, and tactical skills of the university, industry, and the military.

Mr. Martin is Deputy Assistant Secretary of Defense (Applications Engineering) and Director of Guided Missiles. This address was delivered at the Industrial Preparedness Luncheon of the Thirty-seventh Annual Meeting, American Ordnance Association, held in San Francisco, Calif., May 10, 1955.

To maintain our position in this contest, we must be preëminent in many ways:

1. We must keep ahead in the basic research which provides the reservoir of new knowledge from which to draw the fundamentals of new weapons and in the exploratory development which shows how these fundamentals may be applied in needed weaponry.

2. We must keep ahead in the imagination to envision new weapons and the applications thus made possible.

3. We must keep ahead in our skills of developing designs suitable for modern production methods and for use in the severe environmental conditions of today's and tomorrow's weapons.

4. We must keep ahead in our manufacturing technology to get the utmost from resources of manpower, materials, and machines.

5. We must be outstandingly clever in the solution of the supply, logistics, training, and maintenance problems of using in service these new complex devices and systems.

6. We must be in the forefront in developing the techniques, tactics, and doctrines to utilize these new weapons in combat.

This diverse job needs the participation of all. Industry's help must be depended upon, particularly in the areas of design, production, supply, and maintenance. I shall return to these later.

This is a stupendous job. It involves advancing on a broad front and indicates why it should be called a penetration into large new areas. We face the breadth and depth of this problem when we realize also that we do not know definitely what to prepare for. We are reluctant to phase out the conventional weapons until we have more assurance as to what dependence we can place upon the new. The military people naturally feel that such a transition should be based on the acid test of combat experience.

One of the biggest problems today—and probably our biggest technological problem—is the selection of our future weaponry. We must be smart enough to make this selection or we may be over-

whelmed by the very proliferation of our technological advances. We need to give more support to skilled operations analysis and to rely upon its results for guidance in our selection.

The realities of our technical resources tell us we must face the necessity of selection. This is an old problem: n things well done vs. $n + x$ things done not so well. Which things are to be included in n?

Currently we are preparing for the use of both old and new weapons. Also we contemplate combats lasting months and possibly years—an all-out war, a localized Korean-type struggle, and a cold war of long duration.

AND with all this we cannot plan our personal and industrial existence on any other basis than that our present situation is to be a way of living that may go on for decades. We are not considering a transient situation and so our arrangements must be established for the long pull.

Now let us consider the procedure through which a project for the development of a new weapon must pass. We are all aware of the phases of research, development, design, production, and use. In exploring the part of industry in this process, we need, however, to examine these phases closely.

After research which reveals new knowledge, comes development. This word "development" covers two kinds of activities which need to be distinguished.

I have mentioned that exploratory development shows the applicability of new knowledge. If this demonstration of applicability and feasibility—by experimental models, by paper studies, or by both—wins authorization to make something available for production and use, we come into another phase of development the purpose and result of which is a design for manufacture to fulfill an operational need.

To define and guide this latter phase of development—termed "design-development" because a design is its purpose—the military people draw up the military characteristics (or, in the Navy, the operational requirements) which describe the desired performance and application of the new device or system.

The resulting design of equipment is then produced, evaluated, and, if found to be satisfactory, put into service.

Now let us consider this procedure in more detail, because this is where industry's part is particularly important.

In the research and exploratory development phase, it is desirable to have multiple approaches to a new weapon in order to ensure that the likely ways of accomplishing the result are suitably explored. In this activity the military people need to rely heavily on civilian scientists in the laboratories of the university, military, or industry.

When these multiple approaches have been suitably explored and the most likely solutions indicated, the military man needs to take a leading rôle in deciding what kind of a device he wants and what it should do. After he has made this decision he usually turns to industry to develop a design and to produce it.

I HAVE pursued this part of the process in some detail to bring out that the term "development" has been applied to two different kinds of activities which need to be treated somewhat differently. In the exploratory development activity we want multiple approaches with a strong civilian influence, both in planning and execution.

In the design-development activity, where the objective is a specific equipment or system, we want to narrow down, if possible, to a single approach, the selection of which must be the responsibility of the military, but the implementation of which is generally the responsibility of industry.

I have stressed the duality of activities covered by the term "development" because failure to distinguish this may cause confusion in the planning of our military programs. When the term "research and development" is used, some interpret the activity so characterized as covering solely exploratory work.

Actually in our current usage the "development" part of the term consists largely of the more specific phase of development directed to a design of something to be made and used.

This distinction between the two types of development is important for another reason. When it is not recognized that these two types call for different treatment, there is a strong tendency for multiple approaches—which are desirable in the exploratory phase—to persist as multiple projects in the design-development phase and then as multiple items in production and use.

This consideration of the exploratory work and the selection therefrom as to what is to be carried on to provide an item for production and use involves important and often tough decisions. It means stopping some things—and that is hard to do in this kind of work.

It is generally not expensive to have multiple approaches in the exploratory phase. In the design-development phase, however, costs rise rapidly because hardware is being built and many models are needed for the searching engineering and operational suitability tests. It is therefore of great importance to narrow down the field before this phase is entered upon.

It is in this design-development phase that industry participates in a big way. For the new complex weapons on which we are placing so much dependence—guided missiles, aircraft, airplane and submarine detection systems, electronic fire-control and bombing systems, and so on—it is my strong belief that, to the greatest extent practicable, the organization which develops the design should also be responsible for the initial production.

I BELIEVE that for such equipment it is beneficial to have this concentration of responsibility so that design engineering and production engineering can properly affect and react on each other to get the best combination of performance, producibility, suitability for use, and cost. For this operation to produce suitable results the contractor must, of course, be competent in both fields and must apply his first team in both fields.

The contractor should have a suitable quantity in this initial production to foster and justify his developing the

processes and tooling for quantity production.

His production also should cover a sufficient period of time for him to be responsible for incorporating into the design and production such changes as come out of the experiences of production, evaluation, and early service. Then, if multiple sources are needed, this step can be taken on the basis of an established performance and design.

THE policy governing the award of initial production contracts to the contractor who develops a new technical device recently has been clarified and amplified by Secretary of Defense Directive No. 4105.10. This states that "it is very frequently in the best interests of the Government that the initial production contract for such technical and specialized supplies be placed with the contractor responsible for the development of the design" and also that "price advantages alone should not be allowed to dictate an award elsewhere."

This directive also states that "it is preferable that the initial production contractor be responsible for furnishing an initial supply of special testing equipment, special tools, demonstration sets, and instruction and training manuals required for operation, maintenance, and training."

Additionally, it may be desirable in many cases for this contractor to furnish technical assistance for some initial period—six months or a year or so—to help the military personnel in training, operations, and maintenance.

I STRESS this single responsibility for design development and for initial production for today's complex weaponry because in it we are pushing the art in materials, components, and methods of operation to get outstanding improvements in performance.

Along with this—as is often the case in such pioneering—we have our troubles. We find difficulties in making the new equipment stand up under the severe environmental conditions of service.

For example, the conditions with respect to shock, vibration, temperature range, and humidity, are beyond those which we have had to meet before—in some cases, way beyond those of World War II. In fact, in many cases we do not yet know how to specify them.

With this situation, the equipment fails too often in service and calls for too much maintenance. These matters of maintenance and reliability in service go hand in hand and today are big problems, especially in electronic equipment but also in older forms of matériel.

The single responsibility for design and initial production provides an environment for consistent coördination of the factors affecting quality, through the selection of materials, components, circuitry, production processes, and quality-control methods, and for the integration of the dictates of design and production with those of use.

BY this procedure we are setting up a situation which is favorable to clearing out, in the design and early-use stages, many of the troubles that too often otherwise take months and years of subsequent service to reveal and cure.

We are pinning our hopes for military supremacy to a large extent on electronic equipment. Today every military vehicle—in the air, on land, on or under water—is loaded to the guards with electronic equipment which is essential to the mission of the vehicle. If it works—fine; if not—we might be better off without some of it.

OUR office is the sponsor for the Advisory Group for the Reliability of Electronic Equipment—termed "AGREE." It is a group of representatives of the military departments and of industry who seek ways to foster the achievement of reliability. In my campaign for reliability, I have been stating four convictions:

1. I am convinced that the requisite reliability can be attained but that advances and changes are needed in both the military and industry, in both the thinking and in the procedures.

2. I am convinced that reliability cannot be achieved solely by specification requirements and end-point inspections to such requirements; we have got to build it in the product, not try to inspect it in.

3. Reliability is worth money, may call for increases in initial costs—but much can be done without increases.

The B-61 Martin Matador pilotless bomber, shown in launching position, is now being mass-produced for service with the United States Tactical Air Command.

4. To achieve the desired reliability, more responsibility must be placed on industry.

In recognition of the importance of maintenance, we have established an Office of Maintenance Engineering to seek for and foster better maintenance procedures and practices.

A RECENT study has shown that the cost of maintaining electronic equipment in the Air Force is about twice as much per year as the first cost of the equipment. A Navy estimate expressed the maintenance cost during the life of the equipment as about ten times its first cost.

In the Air Force, one-third of the personnel is engaged in maintenance.

In the use of some of our military airplanes today, their availability for a mission may be determined more by the availability of maintenance facilities and skills than by numbers of aircraft.

Obviously increased reliability can pay large dividends—taking account only of the tangible factors.

We cannot keep on adding more complex weapons to our arsenal unless we lick these problems of reliability and maintenance. If we do not, we shall be stymied by inoperative equipment and swamped by preventive and curative maintenance.

THE industry of this country must take the leadership in licking these problems. They have shown their abilities in commercial fields in getting a balance—proper in the interests of the user—among production costs, reliability, and maintenance under the conditions of the user's service. This is indicated by such things as automobiles, radio and television sets, telephones, and many of our household appliances.

In the case of the military, the conditions of the user's service are much more severe, but there can be—and must be—a better balance than we now have between production results and service results. Industry can take a proper part in this, and conditions should be made suitable for such participation.

This means also that some industrial organizations may need to recognize that their responsibilities go beyond what has seemed to them to be the end limits of their own direct interests.

The management of an industrial organization which takes on the development of a new military device or system should ensure that their development engineers and designers have:

(1) A quantitative knowledge of the conditions to which the military equipment is subjected in use, distribution, and storage; (2) Early knowledge of failures and the attending conditions in evaluation tests; (3) Quantitative information of behavior under service conditions; and (4) Analysis of troubles in (2) and (3) to determine causes.

To put all this in another way, the industrial contractor doing a military development job should promote and insist upon the "feed-back" of information from service to design.

As the new item is being developed the contractor should direct attention to the test sets and special tools that are needed to adjust the equipment for its proper operation and maintenance, and to the information that will be needed by the military in training their personnel in such operation and maintenance.

He should consider also what help he may be in supplying technical personnel to assist in getting the equipment into use. Why should the industrial contractor do these things? Simply because he has designed and built the equipment and knows more about it than any one else.

In discussing the design of military equipment, it should be noted that;

1. Many of the devices of our daily life have reached their high level of performance as the result of revelation and correction of troubles through years of service;

2. For our complex and expensive new weapons, we cannot wait upon such a slow process.

For this military equipment we need, and can well justify to the greatest extent practicable, the determination of potential sources of trouble and their correction in the design-development stage.

We need to recognize that the design of a military device, which does not require during its development that each component be selected on the basis of its ability to withstand the conditions of its application, is not good design.

We need to recognize, also, that a reputation for good design is an important characteristic for a contract award, and proof that the design is good is a necessary condition for large-scale production.

In my relations with the American Ordnance Association I have felt that I was dealing with an organization that is not trying to promote narrowly the interests of industry but is sincerely interested in doing an objective job for the military.

Because of this I have felt free to present to the industrial organizations represented in the A.O.A. the problems of the military departments with the assurance that these problems are being and will be given sympathetic consideration—that these industrial organizations are aware of the opportunities to aid in their solution.

I BELIEVE that the military needs the support of industry in helping to make the new weapons available for effective use. It is the job of the military to state definitely what they want and to use effectively what they get. It is the job of industry to give them what they want and to see that it has the maximum effectiveness for the military job.

The attention which has been given since World War II to the application of the advances in technology in ordnance and other matériel has provided the military with a plethora of new weapons. It has also presented to the military a wealth of new problems in the selection, development, and evaluation of these new weapons; in their production, supply, and logistics; in training and maintenance; in the techniques and doctrines of their use.

There is a question as to the rate at which these new tools can be assimilated effectively. Our technical, production, and financial resources call for more selection and concentration than we have had.

Industry can be a big help to the military in these problems. Their solution is a team job and demands the best that the members of the team can provide.

The Navy's Armament

Thirty-seventh Annual Meeting of the American Ordnance Association at San Francisco features technical seminars and trip to sea to witness demonstration of United States naval airpower and firepower

OVER six hundred members of the American Ordnance Association can now be classified as deep-sea sailors after they "joined the Navy" on May 11th for a day at sea to witness test firings by Naval ships and aircraft. The events of May 11th were the climax of a 2-day annual meeting that will go down in history for its excellence.

The enthusiasm of the Ordnance fraternity was evident from the very start when a crowd of over 500 were seated in the Terrace Room of the Fairmont Hotel, San Francisco, scene of all the events of May 10th.

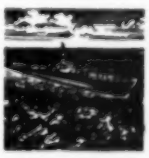
The morning seminar session was opened by Lawrence S. Fletcher, San Francisco Post president. Mr. Fletcher gave the members a friendly welcome to San Francisco and turned the chair over to Henry N. Marsh, Deputy Assistant Secretary of the Army, who, after a brief review of the rôle of the A.O.A. Technical Divisions and Committees, of which he was formerly general chairman, summarized the observations of the speakers he was to introduce.

THE morning panel on "Progress in Land, Sea, and Air Armament" was lead by Brig. Gen. J. M. Colby, commanding officer of Frankford Arsenal, who opened the eyes of many in attendance by relating some of the advantages this country has gained in our overseas procurement program. His paper is published on page 49 of this issue.

Capt. David B. Young, U.S.N., commanding officer, Naval Ordnance Test Station, Inyokern, Calif., followed with an illuminating talk and some excellent slides that impressed on the audience the complexity of armament development, particularly in the rocket and missile field (see page 54).

Brig. Gen. E. P. Mechling, commander, Air Force Armament Center, Eglin Air Force Base, Fla., concluded the morning session with a brief description of the tasks and facilities of the Air Research and Development Command and with both humorous and serious slides and film pictured clearly the amazing strides that have been made in the development of our air weapons that will be followed by even more startling armaments. His paper is published on page 46.

Guests of honor at the speakers' table for this session were Vice Adm. George F. Hussey, Jr., Association president; Lieut. Gen. Levin H. Campbell, Jr., past president; Dean Witter, regional vice-president; B. C. Heacock, chief of the San Francisco Ordnance District; and Vice Adm. W. K. Phillips, commander, First Fleet.



Luncheon was served in the fabulous Tonga Room of the Fairmont Hotel with the guests seated in a tropical atmosphere around a sparkling pool.

Admiral Hussey presided at the luncheon and, after introduction of guests at the speakers' table and announcements on future events of the day by Mr. Fletcher, the Admiral introduced William H. Martin, deputy to the Assistant Secretary of Defense for Applications Engineering. Mr. Martin delivered a message that caused all the members present to lean forward in their seats in rapt attention.

THEY were particularly interested to hear that the Department of Defense desires to see more negotiations where the developer of a military item would have the contract for the first production lot as well as for development. The company selected should be prepared to furnish services for the equipment or weapons system until it has performed satisfactorily in the field. His address is published on page 37.

After the luncheon the meeting reassembled for the afternoon session where Robert L. Biggers, vice-president of the A.O.A., presided. The talks in the afternoon by the panel of distinguished speakers from industry were as outstanding in their field as had been those in the forenoon.

Each speaker presented a phase of industrial preparedness and defense mobilization that contained an extraordinary amount of useful information.

W. J. Reitze, Esso Standard Oil Company, presented in interesting detail the well organized plans that his company has made for ensuring that they can carry on in the event of any type of attack or disaster (see page 57).

Brig. Gen. O. J. Gatchell, American Machine & Foundry Company, told of

(Continued on page 44)

Above, A.O.A. members gather on the flight deck and superstructure of the U.S.S. HANCOCK to watch air operations being staged from surrounding ships. Right, the light cruiser, MANCHESTER, which took part in the demonstration (Navy photos).

Above, the destroyer HOLLISTER saw Korean action and took part in the evacuation of the Tachen Islands. Below, A.O.A. members assembled on the forward flight deck of the HANCOCK get a fine view of the MANCHESTER under way (Navy photos).

Right, the U.S.S. BOXER, veteran aircraft carrier, launched most of the airplanes used in the day's demonstration. Below, two F9F5 Panther jets are catapulted from the deck of the HANCOCK (Navy photos).

Below, the radar picket destroyer, U.S.S. FRANK KNOX, which participated in the tests staged by the Navy for A.O.A. members. The KNOX is equipped with the most modern height-finding radar equipment plus standard air-search radars (Navy photo).

Above, left to right are: L. S. Fletcher, Brig. Gen. J. M. Colby, Vice Adm. G. F. Hussey, Jr., H. N. Marsh, presiding, Vice Adm. W. K. Phillips, Lieut. Gen. L. H. Campbell, Jr., Brig. Gen. E. P. Mechling, and Capt. D. B. Young at the morning seminar.

the preparations that his company had made to ensure continuance of production of the many products they turn out for the armed forces in case some of their far-flung operations are damaged (see page 60).

W. J. MEINEL, president, Heintz Manufacturing Company, made a strong plea for more realistic product engineering to reduce the excessive number of special machines and tools required in past emergencies. He gave many examples of how alert redesign had enabled his company to produce military equipment without expensive single-purpose machine tools, at the same time maintaining or improving the specified performance of the end item (see page 63).

The gala event of the day, the dinner meeting, was held in the sumptuous Gold Room. As members and friends streamed in from the reception, the special guests were taking their place at the long speakers' table. Here was a glittering assembly of distinguished men in industry and Government and senior officers of all three services.

The meeting opened with the national anthem followed by an impressive and solemn invocation by Capt. G. M. Markle, Chaplain Corps, U. S. Navy. After the dinner, Mr. Fletcher, Post president, welcomed the members and guests and introduced Admiral Hussey as toastmaster.

Col. Dean Witter, a regional vice-president of the Association, and General Campbell, past national president, were specially recognized by the toastmaster, and each briefly addressed the meeting.

Vice Adm. F. S. Low, Commander, Western Sea Frontier, the guest of honor, after a cordial welcome by Admiral Hussey greatly pleased the audience by his brisk appeal for the closest possible ties between industry and the armed services. He pointed to the need for continuous watchfulness over administrative and industrial procedures and stressed that only weapons that reach the fleet are of consequence (see page 34).

BEFORE dawn on May 11th, a horde of early risers embarked in buses at Union Square, as the loyal group of liaison members checked their lists by the light of the street lamps. As members filed on board the U.S.S. HANCOCK, moored at the Naval Air Station, Alameda, they were greeted by the executive officer, Comdr. C. R. Doerlinger, and ushered to a coffee bar plentifully supplied with hot drinks and doughnuts.

By 7:30, with the Bay Bridge astern, six jet fighters and an attack bomber were shot from the steam catapults. At this time and throughout the day, the ship's operations officer, Comdr. E. P. Aurand, as official announcer, maintained a well-balanced flow of information. He informed the guests that these were the first steam catapults installed in a fleet carrier and in conjunction with the canted deck would save thousands of tons of fuel formerly consumed in operating the carrier at high speed into the wind prior to take-offs.

Those who were able to squeeze their way up to the flag and navigating bridge levels, found the task unit commander, Rear Adm. T. B. Williamson, and commanding officer of the HANCOCK, Capt. E. R. Sanders, engaged in studying the weather to find a clear rendezvous for the tests and demonstrations.

Also in evidence throughout the day and answering many questions was Vice Adm. W. K. Phillips, Commander, First Fleet, who made the preliminary plans for the day's operations.

As the HANCOCK steamed out toward the Golden Gate, the destroyer HOLLISTER joined as plane guard, and while clearing the steamer lanes there was an interval for breakfast, Navy style, with beans and hot cakes.

THE demonstration opened as fighters and attack bombers from Air Group 14 in the BOXER swooped out of the haze to make simulated diving and strafing attacks on the HANCOCK from all points of the compass.

While the "attackers" departed to form for a "fly-by," four jet fighters

dove in from many thousand feet, each breaking the sound barrier with a sharp explosive noise as the dive ended. With the mist rolling in, Air Group 14 then flew close overhead in full strength to salute the American Ordnance Association.

The following two hours the HANCOCK headed into a strong breeze and choppy seas at over thirty knots to rendezvous with the Task Group. On this run heavy spray flew over the HANCOCK's bow and land lubbers quailed at the sight of the HOLLISTER astern which seemed to be under the waves as often as on top.

MANY members took advantage of this time to examine exhibits of aircraft and armament on the hangar deck, to learn their way about the ship, and to visit engineering spaces, shops, and living compartments where they found all the officers and men more than willing to assist and instruct—a truly hospitable and friendly crew in the real Navy tradition.

As predicted, the HANCOCK broke through into a beautifully clear and sunny area where the rest of the task group awaited their flagship which joined the formation abeam of the NORTON SOUND, a missile-testing ship. The other ships in formation were the carrier BOXER, the cruiser MANCHESTER, and the destroyer picket FRANK KNOX. Big F6F-type drones were launched promptly, and control quickly shifted from the jeep on the HANCOCK's deck to the airborne controller.

The A.O.A is deeply indebted to the San Francisco Committee whose careful planning and wholehearted interest contributed greatly to the success of the Thirty-seventh Annual Meeting. The general chairman was DEAN WITTER *assisted by the following:*

MAJ. GEN. LAWRENCE C. AMES
S. D. BECHTEL
A. HARRY BRAWNER
WILLIAM E. BUTTS
REAR ADM. H. A. CARLISLE
WILLIAM H. CARR
LAURENCE H. COOPER
PAUL DAVIES
STANLEY DOLLAR, JR.
LAWRENCE S. FLETCHER
HARRISON FULLER
G. M. GREENWOOD
J. M. HAIT
BYRON C. HEACOCK
STANLEY HILLER, JR.
EDGAR B. JESSUP
MARRON KENDRICK
J. R. KNOWLAND
A. B. LAYTON
LIEUT. GEN. LEROY LUTES
FRED MAGGIORA
JAMES S. MOULTON
HERMAN D. NICHOLS
J. HOWARD PATRICK
E. R. PETERSON
T. S. PETERSON
D. A. RHOADES
C. E. ROOT
ROBERT G. SPROUL
COL. JOHN M. STARK
LINGAN A. WARREN
WILLIAM E. WASTE
FRED B. WHITMAN

A good twenty minutes was required for the drones to gain altitude and position. Then ensued some minutes of suspense as the target drone approached and the missile launcher followed the changing angle until both fired in rapid succession.

After the missile firing, the 3"/50 and 5"/38 antiaircraft batteries of the MANCHESTER, HOLLISTER, and FRANK KNOX were swinging into action against a drone that was "splashed" seemingly close aboard one of the destroyers. This demonstration of naval ship firepower was followed by an equally impressive series of test firings by Air Group 14. Through binoculars the members watched the Air Group being launched from the BOXER, then crowded aft on the HANCOCK where a large target sled was streamed 1,000 yards astern.

Section after section of fighters, dive bombers, and attack aircraft strafed and hurled bombs, 5-inch rockets, "Mighty Mouse" rockets, and depth charges at the target. The excellent marksmanship was easy to observe as plumes of spray smothered the sled.

As soon as the BOXER cleared the the area to retrieve her air group, the MANCHESTER opened fire with her twelve 6-inch guns, using a moderate range so that the small patterns and dye-colored splashes could be observed.

The 6-inch firing was followed promptly by the HOLLISTER executing an attack on a simulated submarine with underwater weapons.

Vice Adm. F. S. Low, Commander, Western Sea Frontier, delivers the principal address at the dinner meeting held in the Gold Room of the Fairmont Hotel, May 10th.

ENROUTE to San Francisco harbor, Admiral Hussey arranged for a dispatch to Adm. R. B. Carney, Chief of Naval Operations; Adm. Felix B. Stump, commander in chief of the Pacific Fleet; Vice Adm. H. M. Martin, commander, Air Force Pacific Fleet, Rear Adm. M. F. Curts, commander, Cruisers and Destroyers; Admiral Phillips, Admiral Williamson, and the entire Task Group as follows:

"Six hundred members American Ordnance Association desire to express appreciation for splendid demonstration just completed and admiration for organization and personnel who made it possible."

Aërial Firepower Today

The U. S. Air Force is constantly working through ten research and development centers to improve the quality of weapons and to utilize our growing technology for a strong air defense

Brig. Gen. E. P. Mechling

THE problem of dealing with a subject as sensitive as progress in armament is a troublesome one. A full report of progress must, of course, be classified. An historical review of items that are unclassified would be repetitive to a highly informed audience.

The importance of armament is such, however, that it must be emphasized. Lord Trenchard, the creator of the RAF, has told us that "without armament there is no Air Force." Our own Lieut. Gen. Jimmie Doolittle has advised us that "armament is the cutting edge of air power."

It is therefore appropriate that we present some basic considerations in applying armament in our air weapons systems. I would like to discuss briefly the organization responsible for armament progress in the Air Force—the Air Research and Development Command. Finally, I will discuss the importance of understanding the rapidly changing situation in air weapons and armament.

The responsibility for progress in armament, as well as the responsibility for progress in all aspects of complete weapons systems, rests with the Air Research and Development Command.

The responsibility of this command is to attain and maintain qualitative superiority of matériel and to conduct and supervise scientific and technical studies required for the accomplishment of the Air Force mission—to seek new basic knowledge from which improved aëronautical equipment, matériel, weapons, and techniques may be developed.

General Mechling is Commander, Air Force Armament Center, Eglin Air Force Base, Fla. This paper was presented at the Armament Progress Seminar of the Thirty-seventh Annual Meeting of the American Ordnance Association, the Fairmont Hotel, San Francisco, Calif., May 10, 1955.

ARDC also undertakes the development and recommends the adoption of appropriate new and improved devices in systems for the conduct and support of air warfare, including aircraft, missiles, weapons, techniques, and procedures applicable to Air Force purposes.

Our work is done at ten testing and development centers. Our headquarters is located in Baltimore. The entire program is monitored and controlled from this headquarters. Our commander is Lieut. Gen. Thomas S. Power.

Ground radar development is carried out at the Rome Air Development Center, Rome, N. Y. At the Cambridge Research Center, research work is conducted in radio and geophysics subjects.

At Wright Air Development Center, systems work is combined with the developments emanating from our centers into a complete air weapons system in addition to other component development work in electronics and propulsion. This is the oldest and the largest of our centers.

At the Arnold Engineering Development Center we have the world's most modern wind tunnels and power plant test facilities in a gigantic laboratory at Tullahoma, Tenn. The Holloman Air Development Center conducts research and development of pilotless aircraft and guided missiles with their associated equipments.

Our Missile Test Center, with the longest range in the world, is located at Cape Canaveral, Fla. Our Personnel and Training Research Center is located at San Antonio, Tex., with a number of laboratories at key installations throughout the Air Force. Here, studies are conducted to determine the ability of our crews to man the new equipment developed.

THE Special Weapons Center develops the capability of carrying the AEC's latest products in the form of atomic weapons, while the Flight Test Center, located at Muroc, Calif., is one of the finest natural flight facilities in the world.

Our Armament Center, located at Eglin Air Force Base, Fla., is where our bombs, aircraft rockets, guns, and other armament are tested. A complete

armament testing capability has been created in the past four years. Essentially all types of armament are tested throughout all phases of development. The accumulated knowledge and experience is a valuable Air Force asset. Additional capability is programmed to test armament of the future.

The Air Research and Development Command does not work by itself. The needs of the Air Force are fed into the Pentagon by the various operational commands. These needs for new weapons are made known to ARDC, which then goes out to the universities, to industry, and to other governmental agencies, such as the National Advisory Committee for Aëronautics and the Bureau of Standards, to obtain answers as to how these needs can be satisfied.

The resultant weapons systems and associated hardware are coördinated with the Air Matériel Command during the developmental process to ensure that producible, effective weapons systems and matériel are introduced into the Air Force inventory.

Air armament is now recognized as a major consideration in weapons system design. It is of extreme national importance that we maintain continuing readiness to utilize the weapons systems and armament now at hand with full effectiveness, while we in the research and development business are pursuing our quest for even more decisive weapons.

THERE can be no gap in the capability of the Air Force to perform its mission, and the Air Force program is geared to prevent any such gaps.

We have reached a point in scientific and technical progress where the rate of change is tremendous. Let us consider for a moment the immense rate of change in two of the most important qualities of a fighting force—mobility and firepower.

For the first of these, mobility, we may use the maximum speed obtained by man. Although man has been on earth for millions of years, it was not until after 1800 that he was able to travel faster than some 30 to 40 miles an hour on horseback.

In the next 100 years he managed to raise this speed some 300 miles an hour. In just the last few years, speed has been rapidly increasing until 1954 when the speed record was increased 300 miles an hour in the short space of 3 weeks.

Time has been telescoped by technology. In these 3 weeks, for instance, we picked up 300 miles an hour—a speed that has taken us millions of years to attain.

To get a little better grasp of the meanings of these advances in speeds,

let us take an imaginary trip of about 5,000 miles by a series of vehicles, each of which is considerably different from the preceding one. To take this mythical trip we must assume each vehicle is capable of sustained flight for the trip required.

The early biplanes going 90 miles an hour would take 2⅓ days to fly the 5,000 miles. The B-17 could fly this distance in a little over a day. The B-47 would take but 9 hours. We could fly the X-1A there—currently the fastest airplane—in but 3⅓ hours.

A Mach 3 cruise missile would take but 2½ hours. A ballistic missile, traveling at some 12,000 miles an hour, would take a little less than half an hour.

This is not to imply that our problems are too simple—that we are merely trying to increase the speed records. Let us outline just a few of the other elements of mobility—speed, bomb load, altitude, and range of these weapons. All these factors and many more must be balanced together and weighed to come up with superlative weapons.

World War I biplanes carried a half-ton bomb load at an altitude of 3,000 feet for a distance of 250 miles. A B-17, going 200 miles an hour, could carry 4 tons of bombs at 25,000 feet for 2,100 miles. The B-47, a post-World War II development, travels 600 miles an hour with a bomb load of 5 tons at an altitude of 40,000 feet and has a range of over 3,000 miles, with refueling extending the range indefinitely as long as the crew can stand it.

The B-52 is, of course, a further development than the B-47, about which we can say nothing in an unclassified presentation. The B-52, magnificent as it is, is slow compared with delivery vehicles in prospect. The performance curve will continue to go straight up—an almost unbelievable rate of change.

To turn to the second of our two major factors—that of firepower—we find an even more startling situation obtained. Again, for millions of years, there were no explosives on the earth.

Black powder was discovered centuries ago, and we did no better until TNT, twice as powerful as black powder, came into use around 1900.

The first atomic bomb released the equivalent of 20,000 tons of TNT, and we had a thermonuclear explosion at Eniwetok some 6 years later.

AGAIN, I would like to point out the compression of time that has resulted from rapidly advancing technology. In the short space of a few years we have made extreme advances—we now find that one aircraft can carry more destructive power than the combined aircraft of World War II!

Thus we have seen the tremendous impact of technology on the art of warfare, and from this we can draw these conclusions: First, the answer to quantity is quality. Secondly, the revolution of technology has and is revolutionizing warfare. Thirdly, today's war will be fought with today's weapons.

Of even more importance is the fact that we are diligently preparing weapons systems that will meet the threats of the future. We do this by exploiting to the maximum the output of our rapidly advancing, rapidly changing technology.

Thus the quality of the weapons used by the Air Force depends directly upon the excellence of the research and development that precedes them. We cannot afford to ignore any technical avenue of approach toward the building of better weapons.

It is the wisdom with which we make use of the resources made available for research and development that will enable our country to survive or our sons to win on the field of battle in future wars. It is a responsibility that we take very seriously.

A New Army Vehicle

Designed and built by the Four Wheel Drive Auto Company in coöperation with Army Ordnance expressly to utilize the low-pressure baglike "Rolligon" Goodyear tires, the Teracruzer travels easily over ruts, rocks, and soft ground, the cab and body floating levelly while the "walking-beam" framework cradles each pair of tires as they swallow up obstructions.

Arms for Our Allies

The Offshore Procurement Program, in addition to providing guns and ammunition for the NATO armies, has aided European economic recovery and helped reëstablish a dispersed munitions-production base abroad

Brig. Gen. Joseph M. Colby

LAST fall I returned from more than four years of overseas duty, during which period I had spent considerable time in Korea, Japan, Okinawa, fourteen different countries of Europe, and Turkey in Asia Minor. Reports on the care, operation, supply, maintenance, and performance of American equipment in the hands of many peoples of widely varying stages of education, training, culture, and civilization are of such a nature that the engineers, production men, and servicemen of the Ordnance-Industry Team can be justly proud of their efforts.

Design for reliability of performance and ease of maintenance, production to close tolerances, permitting parts interchangeability of the products of many manufacturers, and the provision of supply and maintenance literature, together with training personnel, are the great contributions you have made to the Ordnance program. Today our equipment is in great demand in the four corners of the free world as well as our methods and procedures for production, care, operation, supply, and maintenance.

WHEN I returned home I was amazed to find that great changes in concept of operation and organization had taken place. The Army Ordnance Corps had decentralized its management activities to commodity commands under new strategic concepts and for more efficient operations.

General Colby is commanding general, Frankford Arsenal, Philadelphia, Pa. This paper was presented at the Armament Progress Seminar of the Thirty-seventh Annual Meeting of the American Ordnance Association held at the Fairmont Hotel, San Francisco, Calif., May 10, 1955.

I was glad to learn that the concept of having a costly war reserve of equipment, subject to deterioration and obsolescence, to cover the lag time of a demobilized industry proceeding into production had been outmoded.

In 1933, fifteen years after the first World War, I spent much of my time testing the World War I U. S. 6-ton and Mark VIII tanks in an attempt to develop modification kits that would make our war reserve of these tanks more effective. However, the war reserve was not only deteriorating rapidly but had reached the point where it was obsolete.

The limited funds then available had been diverted to the maintenance of obsolescence, denying funds for research and development of modern equipment.

The new program of plant stand-by, plant layaway, and machine-tool storage provides ready facilities for our industrial-mobilization plans and shortens the lead time to production, decreases the need for costly reserves of matériel, and encourages research and development to keep us technically in advance of current hostile groups.

New stress has been placed on management procedure. The Ordnance Corps has an outstanding management school at Rock Island Arsenal where military and civilian personnel are taught modern principles of organization, procedure and procedure analysis, work standards, reports, management analysis, etc. Obviously this type of training provides more efficient performance of mission with less cost.

ON return home after four years of absence I could easily sense the increasing attention this Nation is giving scientific research and engineering development. This encouragement to the able creative minds of America assures us technical leadership from both military and industrial points of view and affects the lives of both soldier and civilian.

Also easy to note on my return was the greater encouragement given by our Government to our industry and the willingness by industry to participate in the research, engineering, production, service, and planning phases of our Ordnance program. The most difficult phase of World War II was that of getting to know the many members of the Ordnance-Industry Team and their respective capabilites and limitations.

I would like to tell how an Ordnance activity has played a major rôle in the

defeat of Communism in Europe and in strengthening the forces of the free world by renewing hope, courage, and will to fight of peoples ravaged by war.

In the spring of 1952 I organized the Ordnance Procurement Center, USAREUR, and in the next 2½ years supervised the spending in 14 different countries of Europe and Asia Minor of $1.5 billion of the U. S. taxpayers' money.

The background of this story is complex. It really began shortly after World War II when the United States established the Marshall Aid Plan for the economic rehabilitation of war-torn Europe.

The Marshall Plan activities later were absorbed by the Economic Coöperation Administration. Congress had provided that Marshall aid or Economic Coöperation funds were for economic rehabilitation and could not be used for military or armament purposes.

By 1950 the intent and threat to the free world of the Communistic powers had become evident, forcing the Western Powers to join in a defensive alliance—the North Atlantic Treaty Organization. A novel feature of this organization was the provision for the pooling of the military forces of these several sovereign powers under a common military headquarters—SHAPE. This headquarters was organized and run, as you well know, by General Eisenhower until he left to run for the Presidency.

AMONG the important command functions of SHAPE are the recommending of the number of divisions each country is to furnish the NATO Army and the establishment of the tables of organization and equipment of these divisions. Knowing the number of divisions to be organized and with established tables of organization, the fixing of requirements for manpower and matériel is a simple matter.

Personnel to meet manpower requirements was available. But the problems of obtaining funds for equipment and supplies in countries plundered and destroyed by war and occupation were complex. Originally it was planned to exploit the following sources:

1. Indigenous supply availability. However, there wasn't much good equipment left in countries which had been overrun by an enemy.

2. U. S. surpluses from World War II furnished under the military aid plan. The United States had large surpluses, but the advent of the Korean conflict caused the diversion of much of our surpluses to the UN effort in the Far East.

3. Indigenous funded production. However, Europeans were reluctant to divert limited funds from the rebuilding of homes, cities, bridges, factories, and other essential economic necessities to the production of the munitions of war.

The integration of a United Allied Army under SHAPE was proving to be a feasible objective. Why not integrate in a similar manner the European production facilities for more effective and efficient production? This would mean a comprehensive program of standardization and a pooling of orders that would lead to quantity requirements supported by pooled funds.

This would permit the tooling of mass-production lines with the natural result of lower costs, thus meeting the objective of more defense for the dollar, franc, lira, or unit of currency applicable.

This industrial integration also would be another step to the military, economic, and political integration that would wipe out the boundary lines of the small compartmented segments of Europe which for many generations have restrained the free flow of trade, resulted in economic stagnation, and are the lines over which an almost continuous series of wars has been fought.

To accomplish this unified industrial effort, NATO provided an organization with headquarters in London known as the Defense Production Board. The U. S. delegation to this Board was known as SUSREP (Senior U. S. Representative). I joined this organization in March 1951 as chief of its Production Resources Division.

The Defense Production Board was composed of able top-ranking military and civilian personnel thoroughly familiar with the problems of producing military requirements. They approached the problem seriously and evolved several excellent plans for the integrated production of the requirements for a number of specific items. However, their plans failed to materialize because the limited funds available could not be diverted from essential reconstruction.

In the spring of 1951, NATO's armies were still unarmed. The vulnerability of Europe to threatened attack was serious. Why couldn't the restriction on the use of ECA funds for military purposes be lifted to allow them to be used for this purpose and still meet the ECA objectives of economic rehabilitation and balance of payments? Congress agreed they could and gave the green light in fiscal year 1952. The new Mutual Security Agency absorbed the functions of the ECA.

WE now had all the essentials for the Offshore Procurement Program:

1. SHAPE had established the number of divisions and the tables of organization—the basis of requirements.

2. The U. S. Military Aid Assistance Groups (MAAGS) in each of the countries assisted in the establishment of each country's requirements within monetary limitations and screened them for validity and compliance with established criteria.

3. Congress had provided the funds in the MSA Act.

The MAAGS forwarded each country's requirements to JAMAG (Joint Army Military Aid Group), an agency of the U. S. European Command, where they were consolidated and forwarded to the appropriate staff agency of the Army, Navy, and Air Force in the United States. There the requirements were screened against available surpluses, quantities extracted to keep U. S. production lines in operation, and the residue consolidated by service to comprise the Offshore Procurement Program.

By January 1952 the basic ground rules for Offshore Procurement had been established with objectives of the program as follows:

1. To provide arms and ammunition to the NATO armed forces as rapidly as possible.

2. To reestablish the munitions production base in Europe, particularly in the field of expendable supplies, such as ammunition and spare parts. In this way the European countries could become more self-sufficient in supplies, thereby reducing their reliance on the costly support from the United States.

3. To continue certain objectives of the Marshall Plan, ECA, MSA, and the FOA in so far as they pertained to economic rehabilitation, balance of payments, and technical training, particularly in the field of improved productivity.

4. To support the political and diplomatic objectives of the United States and NATO.

5. To support the local governments of Europe in the execution of their own industrial-mobilization plans.

6. To obtain a strategic dispersion of facilities.

NEVER before in history had a procurement officer been confronted with so many objectives other than buying a good product at a good price.

United States agencies having prime interest in the program were the Department of State, the Department of Defense, and the Mutual Security Agency.

In Europe the interested agencies were:

1. The U. S. Regional Office (USRO) in Paris representing Departments of State and Defense and the MSA.

2. The European Command (EUCOM) with headquarters successively in Heidelberg, Frankfurt, and Paris.

3. The American Embassies in each of the countries involved including the local MAAG and MSA (FOA) organizations.

4. NATO Headquarters in Paris.

5. SHAPE.

6. The governments of each of the countries involved including their Ministries of Defense, Economics, Industry, and Finance.

7. USAREUR (U. S. Army in Europe) was given the responsibility for the conduct of that portion of Offshore Procurement which pertained to the requirements for which the Department of the Army in the United States has normal supply responsibility.

The Ordnance Procurement Center was organized under the control of the Chief Ordnance Officer, USAREUR, and with a few exceptions procured only those supplies for which the U. S. Army Ordnance Corps has normal supply responsibility.

While our command channel for Ordnance offshore procurement was from the Department of the Army to USAREUR, to the Chief Ordnance Officer, to the Ordnance Procurement Center,

"Today our equipment is in great demand in the four corners of the free world as well as our methods and procedures for production, care, operation, supply, and maintenance."

never before in history had a procurement officer had to deal with so many widely differing agencies of so many differing governments.

Early in February 1952 the first funded requirements began to arrive in Europe. We at SUSREP in London were pretty concerned over the success of the program, as the late arrival of funded requirements, the lack of immediate availability of drawings and specifications, the necessity to organize and man procurement organizations, and the novel experience of operating through the screen of sovereign powers with facilities in countries of differing languages, laws, customs, currencies, and even different stages of civilization presented a task which seemed almost impossible within the limited time remaining in the fiscal year.

In February 1952, while in Greece on a facility survey, I was awakened in the middle of the night by a telephone call and was told to proceed to USAREUR to take charge of the Ordnance phase of the program. This was approximately as large as the programs of the Air Force, Navy, and other services of the Army combined.

The Ordnance Officer, USAREUR, had a small, well-organized group that was doing an excellent job of procurement by requisition on the German economy of items which were required by the Occupation Forces and which were in short supply from the United States. Payments were made in Deutsch marks in accordance with the terms of occupation. This organization also had made certain dollar purchases in Switzerland and Belgium of proprietary items required by U. S. forces.

The problem now was to organize to accomplish the NATO-wide procurement task. We settled on a setup which was quite comparable to the Industrial Division of the Office, Chief of Ordnance, and the Ordnance district procurement system.

Our central office was located at Sandhofen—a northern suburb of Mannheim, Germany. Branch offices were established in the following cities:

(1) Oslo, Norway, for Scandinavia, with a suboffice in Copenhagen, Denmark; (2) Brussels for the Benelux countries; (3) London for the British Isles; (4) Paris for France; (5) Madrid, Spain, for the Iberian Peninsula, with a suboffice in Lisbon, Portugal; (6) Rome for Italy and Greece, with a suboffice in Athens; (7) Ankara for Turkey; (8) Belgrade for Yugoslavia.

We maintained an inspection office in Zurich, Switzerland; three suboffices at Stuttgart, Frankfurt, and Berlin reported direct to Mannheim.

We also maintained close contact with the MAAG in Teheran, Iran, as we executed a complex procurement program for the Iranian government under the Military Aid Program.

After establishing the organizational concept, the next important problem was acquisition of personnel. People familiar with engineering, production, inspection, and procurement techniques were not available to us from the United States. These classes of personnel were needed in the United States in our industrial support of the UN effort in Korea.

TO offset this, we signed agreements with each of the participating countries which provided that each country would furnish all inspection service subject to our overriding supervision without charge to the United States.

Each country also was to establish an engineering control group to pass on

all requests for waivers or deviations from specifications before submitting them to Ordnance Procurement Center Headquarters for approval. This group would operate without charge to the United States Government.

Since the bulk of our procurement was in the field of ammunition, we were faced with another complex problem. The procurement officer in the United States is backed by Government laboratories and proving grounds. In Europe, we had none of these at our command.

To solve this problem, we drew up agreements with participating countries providing that they would furnish without charge to the United States the necessary proving-ground services. Test weapons, in most cases, came from local stocks that had previously been furnished under Military Aid.

This solution also had the advantage of creating the incentive for the rehabilitation of local proving grounds and the training of indigenous personnel under an active program.

American tradition and custom relative to artillery ammunition have always required that the Government purchase by components, such as cartridge case, shell body, metallic fuze components, explosives, propellant, and packaging. The components are funneled into GOGO or GOCO plants for final assembly.

IN Europe we had no loading plants at our command. To delegate this problem, we contracted not for components but for complete rounds. Therefore, in our contract price we had the benefit of cost of transportation of components and the amortization of plants.

Several people, after reviewing our procedure in Europe, have recommended complete-round procurement in the United States. I do not so recommend; we were forced to this type of procurement in Europe by the existing situation.

In February 1952 we had no drawings or specifications immediately available. In several early invitations for proposals, competing facilities bid with their basic knowledge of the product they were to produce coming from visual examination of the round itself. Drawings, specifications, standard inspection procedures, etc., were distributed as soon as these were received and duplicated.

Problems of differing languages, laws, customs, currencies, etc., were always present.

With the exception of procurement supported by occupation funds, we wrote all contracts for payment in dollars. Our funds were appropriated by Congress in dollars and our expenditures were limited by dollar commitments. We saw no way of dealing with currencies, the exchange rate of which varied widely. For example, the Greek drachma went from 15,000 to the dollar to 30,000 to the dollar.

We were operating through the screens of sovereign power; therefore we made no advance payments and made progress payments only on completed and accepted components. This practice eliminated the complex burden of advance and progress payment administration. We paid when the contractor delivered. The incentive of the American dollar was a great spur to acceptable and timely production.

Guidance for the economic objectives of the program were given to us through channels by USRO, Paris. This guidance was normally in the form of stated dollar volume of contracts desired in each country. We were successful in meeting these objectives with the minimum need for directed procurement.

Most of the contracts were placed on the basis of Europe-wide competition. However, to accomplish these objectives, we were compelled to accept bids where the preaward survey would make an ammunition contracting officer's hair stand on end.

For example, Denmark is largely a dairy and farming country that for the past several generations has scrupulously avoided the armament business. Our low bid for the complete M51A5 fuze came from a small Danish firm that owned about fifteen automatic screw machines. The management staff consisted of the young owner who acted as president, salesman, and foreman. His attractive young wife was vice-president, secretary, treasurer, bookkeeper, and stenographer. Current production consisted largely of parts for a bicycle coaster brake.

OUR preaward survey showed the firm to be technically competent, but the owner's financial position was weak, and we were highly skeptical that he could tool and produce at his low quotation.

We took the Danish Government into our confidence, and they agreed to guarantee performance under the terms of the contract. Today Denmark is successfully producing the M51A5 fuze as well as complete 105-mm. howitzer and 60-mm. mortar rounds of ammunition.

Turkey, under the sultans, was a dead civilization. Kemal Atatürk sparked a renaissance that is now having far-reaching social and economic effects. Large numbers of young Turks are sent to the United States for education. Alumni chapters of the Universities of Cornell and Michigan are active in Ankara. I was surprised to find that these young Turks educated in America were more like Americans than any group with which I came in contact.

However, when making my preaward survey of their government-owned, privately operated plant, I found an ancient array of machinery which included sheet-metal presses, each consisting basically of a die at the end of a large screw. Large spokes—like on a capstan—with heavy weights on their ends were affixed to the top of the screw. When a press job was required, several huskies, stripped to the waist, would start the screw in motion. The inertia of the weights in motion would complete the required draw.

Today, their plant is tooled with modern equipment, and Turkey is producing complete rounds of 105-mm. howitzer and 81-mm. mortar ammunition, meeting the requirements of U. S. drawings and specifications.

All our contracts prior to signature were submitted to the local American embassies for review to assure that they were in conformance with U. S. political, diplomatic, and economic objectives. This close coördination played an

important rôle in the fight against Communism in Italy.

The foregoing were some of our more unusual problems. As you can well imagine, this novel experience presented us with a constant series of events that ran the gamut of emotions and constantly brought up problems for which we had no precedent.

As the pressure of the Korean action began to diminish, we began to get technical experts from our arsenals and proving grounds for temporary duty with us of from sixty to ninety days. In addition, technical experts from American facilities producing ammunition visited us for similar periods of temporary duty. We are deeply indebted to these people for their able and helpful assistance. We believe that the experience of their travel and visits to European facilities was professionally and educationally beneficial to them.

By the close of fiscal year 1954 our program had reached the following size: 200,000,000 Deutsch marks—procurement of supplies for occupation forces from occupation currencies; $1,332,000,000—procurement under the MDAP; $80,000,000—procurement for the Department of the Army; $2,000,000—procurement for the support of U. S. troops in Europe.

By June 1954 we were expending funds at the rate of $33,000,000 a month. All our fiscal year 1952 contracts had completed delivery or were in production. Fiscal year 1953 contractors were breaking into production at a rapid rate.

THE procurement program was proceeding with unbelievable success. Were we achieving our objectives?

The increasing flow of ammunition delivered to recipient nations under the MDAP began to balance the material needs of SHAPE's armies. The stinger on the bumble bee was beginning to grow.

The munitions industry of Europe, which had been robbed of machinery, demilitarized, or destroyed by invading armies, had been rebuilt or rehabilitated and tooled with modern equipment, and a few new plants had been erected.

A munitions-production base was established permitting the local populace to be put to work, increasing the self-sufficiency of the NATO countries for their own material needs and decreasing their reliance on the United States for supply.

This production base has excellent strategic dispersion. For example, small-arms ammunition facilities are found in each country; 105-mm. howitzer ammunition is being produced in Norway, Denmark, Belgium, France, Portugal, Spain, Yugoslavia, and Turkey; 3.5-inch rockets in England, Belgium, France, Italy, and Greece; 90-mm. antiaircraft and tank ammunition in England, Belgium, France, and Italy; 155-mm. howitzer ammunition in England, Belgium, France, Italy, and Greece. Component producers are located so that they support two or more strategic areas.

"The manpower and material resources of Europe—postwar liabilities—have been converted to effective assets in the free world's fight against Communism."

Widespread European competition broke any attempt at price fixing. Whenever practical, we signed fixed-price contracts. The profit incentive with low competitive prices compelled producers to reëxamine the equipment of their production lines, the flow of matériel, and to place into competition their supplier sources. The resultant improved productivity was sharp.

For example, the French Government had been buying limited quantities of 105-mm. howitzer ammunition at $48 a round. In fiscal year 1953 we bought 105-mm. howitzer ammunition for $24 a round. And while we did not buy this round in 1954, we did receive quotations well below this price.

I know of no better form of economic aid than this type of activity. Funds provided quickly proceeded in the form of wages to the laborer, producer, and technician—the base of the economic structure. Their wages, in turn, being used for food, clothing, shelter, amusement, etc., had a pump-priming effect which I personally believe to be greatly contributory to the vastly improved economic condition of Europe.

In the spring of 1952 I visited a plant in Italy. After plowing my way through weeds, I found a plant with all machinery stolen and the roofs and walls caved in by demolition. During the inspection, a few hungry-looking, ill-clad curious individuals had found their way into the buildings. The looks on their faces were anything but friendly.

Late in the fall of 1953 I revisited this same plant. Walls were up, roofs were on, and machinery was humming a tune that is music to any production man's ears. I was greeted warmly wherever I went.

The owner told me that a few weeks earlier a group of Communist agitators had arrived at the gate at shift time and had begun their vitriolic propaganda of hate against the "U. S. warmongers." They were promptly picked up by the workers and dumped in a near-by creek. The people of Europe recognize and appreciate this form of U. S. help.

IN the summer of 1949 I had the good fortune of traveling extensively in Europe on a technical mission that brought me in close contact with the local populaces. I was amazed to find the sense of hopelessness and lack of courage that existed. Time and again I was told that all was lost.

The job of rebuilding their industries was of such a magnitude that to regain their prewar position was impossible or at best would take many years.

They knew there were individuals in their communities with little black books who were listing the names of those who made any overt show of opposition to Communism. They didn't want to become candidates for the Communist slave camps.

Today these same people can see smoke belching from their factories. They can see the ammunition for the doughboy, artilleryman, tanker, or fighter pilot being produced at their doorstep. The hopelessness is gone. Courage to fight for what they believe right is recaptured.

The manpower and material resources of Europe—postwar liabilities—have been converted to effective assets against Communism.

Integrated Research

An F-86D Sabrejet fires two Mighty Mouse rockets.

Capt. David B. Young, U.S.N.

Captain Young is commanding officer of the Naval Ordnance Test Station, China Lake, Calif. This paper was presented at the Armament Progress Seminar of the Thirty-seventh Annual Meeting American Ordnance Association, held in the Fairmont Hotel, San Francisco, Calif., May 10, 1955.

THE Naval Ordnance Test Station at China Lake, Calif., effectively integrates in one organization all the knowledge, skills, and facilities required to operate a development center for complete weapons and weapons systems.

China Lake is located in the Mojave Desert, near the northern edge and tucked away behind the Sierra Nevada. Our first large piece of real estate there was chosen near the end of World War II by the Navy Bureau of Ordnance and the California Institute of Technology to further the research and development of aircraft ordnance weapons.

The major site alone contains approximately 1,000 square miles, without including another 767 square miles to the southeast. For air-to-water and underwater weapons there are other facilities in Pasadena, Azusa, Long Beach, and San Clemente Island.

The Navy, through the Bureau of Ordnance, has brought together at the Naval Ordnance Test Station a military-civilian team backed by excellent facilities. This team is capable of ascertaining the needs of the Navy and the fleet and translating these needs into weapons—both as improvements upon present weapons and as the weapons systems which will be required eight or ten years from now.

To enable this team to function effectively a well-drawn set of operating principles has been agreed upon. These principles spell out clearly the responsibilities of the military part of the team as well as the technical management part of the team. Under such a charter, we believe we have already accomplished many of the improvements recommended by the Riehlman Committee for better Government operation of research and development laboratories.

Superior officer personnel and civilian scientists, engineers, and craftsmen are required to carry out this mission. Superior officers have been assigned to the Station by the Bureau of Ordnance, and to attract and hold superior civilian scientists and engineers we have been attempting to meet what appear to be the basic requirements.

SEVERAL studies have been made recently to establish how scientists and engineers can be attracted to Government development and research. Indications are that the work program must be challenging and interesting, the

need for solution of the problems must be real, the leadership must be outstanding, working conditions must be genuinely attractive, there must be a real degree of scientific freedom, and the scientist or engineer must be convinced of the integrity of the work being done.

THE organization must be effective but with a minimum of restrictive regulations. There must be positive incentives for the interchange of ideas and the ability to grow professionally. Because most of these incentives are present in the situation at China Lake, the Navy has been able to create, even in the arid Mojave Desert, a weapons-development center with a total population of 12,000 people.

Within this military-civilian community exist all the talents and skills to conceive new weapons or weapons systems and to carry them through the full development cycle, calling upon basic and applied research where necessary.

In addition, the Station is equipped to place a weapon into pilot production with full emphasis on product engineering and, if necessary, coördinate with Government and industry a full-scale national production of the weapon. Full evaluation and test facilities are available to assure that the various criteria for acceptance can be met.

We also have been singularly fortunate to have had, at the local level, the freedom to use some of the funds in the research and development area for what we call "exploratory and foundational research"; that is, to exploit new ideas in ordnance to the point where they can be demonstrated to have a secure place in the weapons systems planning for the future. Such funds, although a small portion of the total budget of the Station, represent the leeway needed to develop new ideas by our talented scientific and engineering group.

TO round out this picture I would like to discuss an example of the kind of weapon development I have been talking about. The 2.75-inch air-to-air folding-fin rocket, nicknamed "Mighty Mouse," represents a complete weapon developed by the Naval Ordnance Test Station to meet conditions established by the Navy Bureau of Ordnance.

This rocket bears small resemblance to the aircraft rockets of World War II. Weight has been cut drastically by the use of aluminum motor tubes, a new solid propellant has been developed which is uniformly stable over a large temperature range, velocity has been increased significantly, and fuzing and head design have been made markedly more effective.

Techniques have been advanced to the point that this rocket can be completely "plant-packaged" in disposable launcher pods for either internal or external use on aircraft.

THUS, by bringing to bear the combined talents and facilities of the Station, development of the Mighty Mouse was completed by 1951 and the weapon placed in full-scale national production. Since then, over ten million have been manufactured for the armed forces.

To produce these rockets we called in just such men and companies as are represented by the A.O.A. These industrial firms include, among others, the makers of washing machines, watches, household appliances, fireworks, tubing, stamped and drawn parts, and plastics.

To ease the transition from development to production, we prepared a film

Aërial view of the Naval Ordnance Test Station, China Lake, with Michelson Laboratory in foreground.

that would help contractors understand the underlying problems and the reasons for the design. With this information we believed contractors would be in a better position to produce exactly to the drawings and specifications, thus eliminating time lags.

The Mighty Mouse is a typical example of the way our military-civilian team effectively integrates research and development. Projects in the other major programs of the Station are approached in much the same way. In fire control, the availability of pilots, aircraft, and ranges in close-working coöperation with the technical staff has resulted in rugged, accurate, reliable systems for guns, rockets, bombs, and missiles.

Some of these are already in use in the fleet, and a majority of all naval aircraft carry fire-control systems engineered here. For undersea weapons the Naval Ordnance Test Station has technical direction of the Navy's aircraft-launched antisubmarine torpedoes.

Product engineering is stressed in all these programs because the members of the team representing industry will be called upon eventually for economical mass production.

THE development process of the Mighty Mouse started in an experimental laboratory concerned with propellant formulation. After a new propellant was devised, manufactured, and loaded into rocket motors made in our shops, the experimental rounds were temperature-conditioned in ovens which can maintain temperatures of from minus 65 to plus 165 degrees Fahrenheit. The rounds were then test-fired on our ground ranges.

Test firings are covered by a complex array of specialized instruments, such as the Bowen ribbon-frame camera. This impressive camera was designed in its original form by Dr. Ira Bowen, now director of the Mount Palomar and Mount Wilson Observatories, during his service in the early days of the Station when it was operated by the California Institute of Technology under Navy contract. The Bowen camera obtains a film record on 5½-inch aërial roll film.

Motion-picture records of flight tests are obtained with the aid of a powered tracking mount, which is an adaptation of a quadruple caliber .50 machine-gun mount used during World War II for antiaircraft purposes. Still further data are secured through the use of Doppler radar. The Sperry Model 10A reflection Doppler radar used at China Lake is a big brother of the sets used by police for highway patrol work.

All of this instrumentation results in a tremendous mass of film records which funnel into the central photographic processing laboratory where more than two million feet of film are processed each year, making the Naval Ordnance Test Station one of the Nation's largest users of sensitized materials.

The records are then assessed in complex machines especially developed by the Station for rapid data reduction. This equipment, with its flashing lights and push buttons, approaches science-fiction gadgetry but has proved accurate, fast, and reliable.

Twelve 2.75-inch rockets are packed in this Starfire wing pod and covered by a fiber glass tip which disintegrates automatically before the rockets are fired (Air Force photo).

Reduced data results usually end up in the form of IBM punched cards which are processed through an IBM Model 701 high-speed computer—one of this Nation's handful of so-called "giant brains."

In the development of the Mighty Mouse, after such data from ground firings had been assessed, tests were run with combinations of rockets, launchers, and firing aircraft.

The Mighty Mouse is a weapon of the present. It is already in the Nation's arsenal of defense against bomber attack.

THE Station's annex, located in Pasadena, devotes its major attention to the development of underwater ordnance, particularly torpedoes. These weapons are tested with the huge variable-angle launcher located at Morris Dam above Azusa and then at sea on our sea ranges. To obtain preliminary performance data quickly and economically, however, a unique simulator duplicates most of the characteristics of a complex and time-consuming sea run right in the laboratory.

By accurately projecting the information now available, our planners strive to predict the weapons we will need tomorrow. They are ahead of the rest of us in analyzing and forecasting new weapons systems.

Our research scientists are hunting better fuels, more effective explosives, less expensive fabricating materials. Our designers are ever on the lookout for ways to improve reliability and effectiveness and for means of reducing complexity so as to improve dependability in combat as more powerful and versatile weapons are developed to meet the needs of modern combat.

Our industrial engineers keep ever in mind that ultimate goal of economical mass production which is the final responsibility of industry.

THE Naval Ordnance Test Station is a weapons-development center with the facilities, the flexibility, and the challenge to attract the superior personnel we need to do the job well. With your help we will be ready with the weapons of the future when they are needed for the defense of America.

System for Survival

How a modern company has made preparations to carry on manufacturing operations in event of emergency, including dispersed control centers, special communication lines, food caches, and underground storage

Wilbur J. Reitze

Esso Standard Oil Company, New York, N. Y.

THE most effective way to protect our industries from enemy attack would be to place them underground, but the cost of doing this is prohibitive, and we must look to other means for optimum protection. This planning activity consists of several steps. Naturally the Esso Standard Oil Company on the East Coast is very much interested in such planning as several of our large refineries are located adjacent to the metropolitan area of New York City which many consider a prime enemy target.

One of the first steps in defense planning of a multiplant operation is the organziation of a corporate security committee. Such a committee should be responsible for developing a plan to meet any foreseeable emergency and should be composed of medical, manufacturing, welfare, communications, and legal representatives.

The chairman of the committee should be responsible for the development and coördination of the plan. He must be given the authority and, a very important item, time to perform his function.

WE know that many emergencies, caused by enemy action or by natural causes, leave industrial equipment with only minor damage while inflicting heavy casualties on personnel. For industry to resume production rapidly under such circumstances it is necessary that our personnel be protected and a plan of continued responsibility of the management of the industrial company be maintained. Our company maintains various emergency squads in all our units for the welfare of our personnel. Shelter areas have been designated and directional signs to them posted.

This paper was presented by Mr. Reitze at the Industrial Preparedness Seminar of the Thirty-seventh Annual Meeting of the American Ordnance Association held at the Fairmont Hotel, San Francisco, Calif., May 10, 1955.

Management should plan to anticipate leadership shortages in personnel and should have qualified replacements available in event of an emergency. A complete inventory of personnel, indicating their capabilities and skills, should be available. This arrangement will provide good flexibility in providing personnel for almost any type of emergency.

This plan is carried out for each autonomous unit of a decentralized management. For example, such a plan is carried out in each of our company's six refineries and in our grease plants. We in the petroleum industry are especially fortunate in that our refineries are similar in many of their operations. With our program of rotating key personnel, such persons become familiar with the operation of our various plants.

In addition to a continuity in management during an emergency, an alternate company headquarters should be established and furnished with the essential equipment and facilities to permit effective operation of the reconstructed executive team during the emergency.

OUR company has such an emergency control center established as part of our over-all security program for our New York headquarters. The function of the remote-control center is to be a secondary headquarters in case of emergency to serve as a communications center primarily for executives who will act as a policy- and decision-making group.

This emergency center is located about thirty miles from New York City and is intended to be used on a temporary basis since it facilities will accommodate only a limited number of key personnel. In addition to the watchman and caretaker personnel we also have several people permanently located at this facility.

Various departments of our company keep important duplicate records at the center. We have built an air-conditioned vault for storing microfilm originals, and another copy is stored in a similar vault in the Middle West. We

have found microfilming to be practical, and it saves much storage space.

Telephone communication is provided from this center to sixteen employee reporting centers in the New York metropolitan area and to all our manufacturing units. We also have teletypewriter machines tied in with the telephone company and Western Union. Arrangements were made to have our telephone lines located inland and pass through noncritical target areas to ensure, in so far as possible, continuance of service during an emergency.

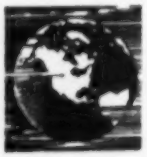
This remote-control center also has provisions for sleeping accommodations for part of the personnel while the balance will commute daily to the center. We also have kitchen and dining-room facilities and a cache of food available.

IN determining the site of such a remote control center, care should be taken in its selection to ensure that it is not located too close to a target area.

We have made several "dry runs" at the center to determine the effectiveness of our plans. Several such runs were made last year, and this year we had one in March with our Jersey board of directors in attendance.

A typical problem was given to the remote-control center with a request from Washington to supply 200,000 barrels of 115/145-grade aviation gasoline for shipment to North Africa. In handling this problem it took a total of only fifty minutes to make all arrangements. Tankers were also diverted and shipments delivered to North Africa in a little over 2½ weeks. This is certainly speed with a capital "S".

Each New York employee has an identification card, and included as part of the card are instructions as to which reporting center the individual will report in an emergency. I might also add that our treasurer's department has arranged to take care of emergency payments in event of a disaster and that all pay checks are written and available at reporting centers and require only one authorized countersignature.



Since our remote-control center will be the primary source of liaison with the New York area reporting centers, we indoctrinate our personnel from these centers on the facilities and arrangements available at the center. The area reporting centers, incidentally, work very well in our marketing setup in that we are able in most instances to utilize bulk plants or district offices as area reporting centers.

For our refinery staff, the plant area reporting centers are generally the homes of designated executive plant personnel. Important records and files are kept at these locations. Arrangements have been made with the telephone companies so these home phones will be given a preferential status in emergencies.

Key plant personnel have cars equipped with radio communication, and this equipment, together with other refinery mobile radio communication equipment, will be assigned to the respective plant area reporting centers. The location of these reporting centers anticipates that in case of emergency the movement of traffic might be restricted and that it may be necessary for most of the personnel to walk to their respective locations.

We are interested in the effect of radioactive fall-out in the event of a radiological attack. In such planning it is immediately obvious that we must coördinate closely with the civilian defense agencies to determine the intensity, direction, and approximate time of arrival of the fall-out in order that adequate precautionary measures can be taken. Many of the plans mentioned above also will apply in planning for an atomic fall-out.

It is essential that adequate shelter be provided for our refineries as well as all our personnel during the fall-out. Movement of personnel in our plants during this period would be at an absolute minimum, and our refineries would be on holiday schedule.

The remote operation of key equipment should be considered. This type of remote-control operation is already extant in most of our modern refineries. The special training of personnel, the providing of sufficient monitoring equipment, and provisions for canned food and water should be made.

The decontamination of key areas as soon as the fall-out has ceased should be planned in advance. Since the fall-out pattern will cover approximately 200 miles and be about 40 miles wide, it is necessary that the planning and coördination be highly efficient since several of our refineries could be located in this area.

For many industries, conversion from peacetime production to wartime production is a major problem. However, we in the petroleum industry are somewhat more fortunate in that we can change to the products required for wartime purposes without worrying about the problem of retooling. There will be times when it might be necessary to add facilities to manufacture certain specific products, but additional refining capacity is available which we believe sufficient for emergencies.

We also include in our plans provisions for supplying many types of specialty petroleum products which would be suddenly required by the military in time of emergency. We maintain contact with all the governmental agencies so that we are always up to date on changes in military specifications or in the issuance of new military specifications concerning petroleum products. This information is given to our laboratories so that they can determine what products or what research work will be required to meet these specifications.

WE periodically issue a booklet to all the governmental agencies concerned showing our products that are approved against these specifications. An example of the importance of this type of product planning is the development of synthetic oils to lubricate the jet engines in all our military aircraft.

We include in our plans provisions for the continuance of the availability of petroleum products. This problem would be especially acute following an enemy attack. It is necessary under such conditions to be sure that sufficient petroleum products are available for the military in order that they may carry out their retaliatory missions. This emphasizes the importance of safeguarding products in storage.

Fragmentation bombing followed by incendiary bombing proved quite destructive of petroleum storage during the last war. The greatest danger to oil tankage when in the perimeter of an atomic bomb explosion would be from fire. About the only economical method of minimizing this type of damage is sufficient tank spacing and the provision of earth fire banks around the tankage. This procedure is standard practice in the oil industry.

IT appears that the high heat from an atomic explosion will greatly accelerate the vaporization of petroleum products. One of the dangers here would be the ignition of rubbish, paper, or vegetation, which in turn would ignite the petroleum vapors. At our refineries and bulk plants we have an intensive housekeeping program to protect against this and, of course, good housekeeping is always good business.

There are other methods of storing petroleum products such as using man-made or natural underground reservoirs. We at present are using one large underground reservoir for our heating-oil storage. This reservoir is a large slate quarry in Pennsylvania. It is connected to the Bayway Refinery by a pipe line and has a capacity of about 42,000,000 gallons. This storage, incidentally, is sufficient to meet the annual heating requirements of the city of Washington.

This quarry has a floating roof in the form of a number of sectional steel pontoons to prevent evaporation and contamination of the product. It also prevents ducks and geese from landing on the surface. By holding the level of the oil slightly below the surrounding water table, it is possible to hold the oil in the reservoir by water pressure.

FROM a defense standpoint such an arrangement for the storage of petroleum products is ideal as these slate quarry pits happen to be located out of a target area and are not vulnerable to fragmentation bomb attack. It would appear that such an installation as this would withstand almost any type of attack short of a direct hit.

While we are considering storage problems of products we are also considering the problem of the storage of drinking water. We have in our New York offices and in our refineries supplies of canned sterilized water for our personnel. This water also can be used with blood plasma.

Industrial disaster plans must include the possibility of blasts like this recent atomic test explosion (Army photo).

One of the obvious and easy means of storing drinking water is to use containers which previously have been used for the storage of gasoline. We have advised all our refinery and marketing units of procedures for decontaminating containers used for leaded gasoline so that they might be used for drinking-water purposes.

These procedures always require complete steaming and flushing of the gasoline tanks. Smaller type vessels can be cleaned out by a series of flushing operations, including washing with strong soap.

A little over a year ago when we had a serious drought in the East and a number of small Jersey communities had a water shortage, we made preparations to supply them by tank, truck. However, just as we were getting ready to deliver our first truckload of drinking water, the rains came.

HERE is an application which, while designed for defense purposes, can readily be adapted to relieve distressed communities in times of peace.

We all know that in cases of emergency the Federal Civil Defense Administration has far-reaching emergency powers covering the control of defense activities of industry as well as civilian aid. In order that we may cooperate with these agencies we have encouraged our supervisory personnel to take active parts in such organizations so that in an emergency we may better coördinate our activities with those of the civil defense organizations.

This is a very important phase of defense planning as it will be necessary in cases of emergency that certain key industries have top priority of available facilities and manpower.

I hope and pray to God that we may never have to use any of these emergency plans. But if such an emergency arises, proper planning, we feel, will minimize the disruption of our production, protect our personnel, and contribute to national survival and victory.

EDITOR'S NOTE.—This is the first of the papers delivered at the Industrial Preparedness Seminar of the Thirty-seventh Annual Meeting of the American Ordnance Association. In this paper Mr. Reitze outlines the very complete preparations made by his company to continue production operations in the event of enemy attack on this country.

Brig. Gen. O. J. Gatchell in the following article cites the necessity for industrial mobilization planning in preparation for full production in time of emergency.

The article, "Trends in Preparedness," by William J. Meinel (p. 63), stresses the importance of preserving our forces of trained technicians and preventing the deterioration of our production equipment through enforced idleness.

Mobilization Planning

American industry now is learning how to prepare in peace for the wartime manufacture of military supplies and matériel by tentative schedules of production, contracts, and emergency operating plans

Brig. Gen. O. J. Gatchell

American Machine & Foundry Company, New York, N. Y.

This paper was delivered by General Gatchell at the Industrial Preparedness Seminar of the Thirty-seventh Annual Meeting of the American Ordnance Association held in the Fairmont Hotel, San Francisco, Calif., May 10, 1955.

WHEN we speak of war planning of any kind, whether it be for the mobilization and training of manpower for our armed forces or mobilization of industry to supply and equip those armed forces, it is commonly referred to as planning *for* war. In a sense it is, because we are making plans for what to do if war should come; but it is also planning *against* war, because preparedness is a major preventive of war.

In this modern, scientific world, industrial preparedness is a particularly potent weapon for peace. It is our industrial might and know-how which a potential enemy fears much more than our manpower. Therefore, it is only common sense to make plans to harness our industrial power with maximum efficiency and to make no secret about the fact that we are doing so.

For a number of years immediately following World War II, industrial mobilization planning naturally placed great emphasis on the lessons learned from that war. The experiences of the war were fresh in the minds of planners, both in Government and in industry, and those experiences dominated their thinking.

Gradually, however, as new weapons were developed, new strategies conceived, and new geopolitical concepts formed, planners began to think more in terms of *195X*.

It is a mistake to plan for future wars entirely in terms of past wars. World War II was very like World War I in some respects but very different in others. World War III, if it comes, will certainly be different from World War II. The fundamental principles of industrial mobilization planning do not change, but they find new application in each succeeding war.

The big, striking difference in planning for any future general war, as compared with past wars, is that now we must assume that American production must be accomplished under enemy attack by atomic or hydrogen bombs. Make no mistake about that! Most probably we shall also be exposed to sabotage on the ground—such as we have never known before.

Therefore, it doesn't make sense to plan war production without taking into account the fact that this production may be subject to enemy interference. So, for the first time, preparations for the mobilization of industry and plans for continuity of operations under attack must be integral parts of the same planning. Accordingly, our planning has resulted in an Industrial Mobilization Plan of five separate parts:

Part I consists of an introduction to the plan, a statement of its scope and objectives, and a frame of reference for mobilization production plans and continuity of operations under attack.

Part II describes the company's facilities, productive equipment, products, and engineering research and development services.

Part III contains capability surveys of each facility, with plant layouts, an analysis of present production and potential productive capacity, and an allocation of that capacity to military, military-supporting, and civilian requirements. These surveys will not be allowed to remain static but will be revised periodically or when some major change requires revision.

Part IV is devoted to implementation of the plan and consists of company directives, standard practice instructions, and assignments of administrative responsibility. This part of the plan will, of course, be under continuous review.

Part V covers security and continuity of operations. We now have in effect, at all facilities engaged in defense work, a thorough system of plant security which has won Government commendation. It includes an employee-identification system, measures for the

prevention of sabotage, armed guards, and civil-defense training. There are additional measures, however, which should be taken and which are covered in Part V.

Before going into any further detail, let's ask ourselves a few questions about the why's and wherefore's of industrial mobilization planning.

First, "What is industrial mobilization or, more particularly, industrial mobilization planning?"

It is defined as: "The planning in peacetime for the production of military supplies and matériel in wartime." More specifically, it is (1) the negotiation of tentative schedules of production, (2) contracts for industrial-preparedness measures, and (3) plans for continuity of operations under war conditions.

A tentative schedule of production is more or less a peacetime gentleman's agreement between a manufacturer and the Government that in case of war the manufacturer will be given a contract to produce an item in the quantities scheduled.

PLANNING at American Machine & Foundry Company began, as all mobilization planning must, with a survey of our facilities. Surveys of each of our company's manufacturing plants were made at the instance of the New York Ordnance District which is the Armed Services Procurement Planning Office for AMF.

The purpose of the surveys was to determine the following: The present and potential capacity of each facility; the probable effect of mobilization on the production of items presently manufactured; and the items or types of items which each facility was best prepared to produce in event of industrial mobilization.

In more detail the surveys included:

1. An analysis of present capacity and maximum capacity, assuming availability of manpower and materials.

2. The percentage of the maximum capacity which could be expected to be available for civilian work.

3. The percentage to be reserved for unscheduled military and military-supporting production.

4. The percentage already scheduled for existing tentative schedules of production.

5. The percentage available for the negotiation of additional tentative schedules of production.

The results of these surveys are analyzed in Part III of the company plan.

MANY assumptions and variables were involved in the computation, evaluation, and analysis of the data, such as the type of products, the ratio of cost of materials to labor, the number of work-hours per week, the number of employees on each shift, the extent of balanced production, allocation of direct and indirect production hours, the amount of subcontracting to other manufacturers, and many others. When these factors could be identified and evaluated, allowances were made for variations in the case of individual facilities.

In accordance with instructions of the Department of Defense, all estimates were based on assumptions of availability of materials and manpower.

The estimates were arrived at as a result of conferences with plant managers, headquarters officials, and officers of the subsidiary companies.

All computations were based on the assumption that the products listed, or similar items, would be produced in the event of mobilization.

In estimating the dollar value of production, some allowance was made for the effect of subcontracting certain parts and components to other manufacturers.

Credit was taken in some instances for increases as a result of greater use of existing facilities by better balanced production as a result of subcontracting.

In arriving at the estimates of maximum capacity, no assumption was made as to any new construction or increase in physical facilities by purchase or lease, although plans for expansion have been made at various times for the American Machine & Foundry plant at Buffalo, DeWalt Inc., at Lancaster, Pa., and the Junior Toy Corporation plant at Hammond, Ind.

The productive capacity expressed in man-hours is for the maximum capacity under mobilization. No estimate was made for the production during the period of conversion or transition. Some lag in production is to be expected during this period.

The estimated maximum capacity of each facility was allocated in the following manner:

1. *To civilian production.*—The percentage allocated to civilian production was based on (a) the plant manager's estimate in the facility survey of the civilian items desired to be produced and (b) an estimate of the amount of such production which would be permitted under the Defense Materials System and other Federal controls.

2. *To unscheduled military and military-supporting production, including subcontracts.*—This includes all items under both prime and subcontracts for military items which are not included in the tentative schedules of production and dual-purpose items which are produced for the military or for the support of military production.

3. *To scheduled production in accordance with existing and valid tentative schedules of production.*—This represents an estimate of the man-hours required for maximum production in any one year under the TSP's.

4. The remainder of the maximum capacity of each plant was then considered available for scheduling for prime contracts under tentative schedules of production. The percentage allocation of aggregate maximum capacity in the event of mobilization was as follows: Civilian production, 16 per cent; unscheduled military and military-supporting, 23 per cent; existing and valid TSP's, 13 per cent; available for TSP's for prime contracts, 48 per cent.

THESE percentages will, of course, change as additional tentative schedules of production are secured.

"The core of any company involved in producing technical products is the engineering and management team. If this basic force is kept together, a stable company results . . . which contributes to national technological progress on a continuing basis."

Implicit in all industrial mobilization planning is the rôle of engineering research and development. It is manifest in: research and development contracts, industrial preparedness measures, the development of prototype military items, and in the design, redesign, or modification of material as a result of battle experience.

It is also manifest in the development and use of substitute materials, assistance in the conversion of facilities to war production, liaison with Government research agencies in the development and use of new materials and processes, and in application of military developments to civilian items after the war.

Some of these areas are in the field of present activities; some lend themselves to more or less definitive forward plans; all are to be integrated with the company's industrial mobilization plan when made fully operational.

The outbreak of hostilities will bring about not only drastic changes in production but also drastic changes in the demands on engineering. The most obvious and immediate of these is the requirement to produce drawings, bills of material, and other necessary engineering information so that matériel manufacture can be started.

THERE is another very striking change which occurs. If the enemy's security preparation has been effective, new weapons and techniques will appear. This immediately gives rise to the necessity for high-pressure research and development to produce countermeasures.

But there is another way in which engineering research and development can be a very important factor in providing for most efficient industrial mobilization, and that is by providing stability within an industry. It is impracticable to assume that we can acquire stability by maintaining a certain level of employees within an industry or by maintaining a certain volume of production.

Economic situations and the exigencies of the times preclude such assumptions. Employment and production are bound to rise or fall with an individual company's ability to remain competitive by bringing along products the armed forces are willing to procure.

The core of any company involved in producing technical products is the engineering and management team. If this basic force is kept together, a stable company results—one which is thereby a member of a stable industry. It is also a company which contributes to national technological progress on a continuing basis.

Being realistic, it is somewhat difficult to imagine that the national economy can stand subsidizing a high-level production program for industry, but it is not difficult to realize that the national economy can afford subsidizing research and development throughout industry in addition to that performed by the Government itself and in university laboratories. It would be only sound insurance.

There have been three recent developments in A.M.F.'s industrial mobilization planning. First, steps have been taken to inform our individual plants as to what the company's plans are for ensuring continuity of operation under war conditions and as to what the plants themselves are expected to do to minimize the effects of enemy attacks. Time does not permit a detailed discussion of Part V of our company plan, which is devoted to this subject.

Briefly, however, Part V includes plans for the duplication and safeguarding of all essential records; for the establishment of an alternate headquarters for the company; basic plans for plant security and civil defense; plans to minimize the effects of enemy attack upon personnel and property; plans for interplant assistance in case of disaster and, if necessary, for the transfer of work from one plant to another; and, finally, for the rehabilitation and reconstruction of damaged or destroyed plants at the same site or elsewhere, so that continuity or production may be maintained to the maximum extent possible.

Secondly, a more detailed resurvey of our plants is in progress to determine plant capacity and capabilities with a view to securing additional realistic tentative schedules of production.

Last but not least, there has been established within the A.M.F. organization a Defense Products Group. This group was created six months ago with the purpose of concentrating under one head the control of all defense activities at all A.M.F. establishments. The headquarters of the group has just been transferred to Alexandria, Va.

The organization provides for a staff consisting of directors of operations, customer services, contracts, planning, fiscal control, administration, personnel, and security. Several of our A.M.F. plants which are almost exclusively on defense work are an integral part of the group and the plant managers report directly to the group executive.

At each dual plant which has both Government and commercial work there will be a defense products manager who will be responsibile for the proper execution of defense orders at that plant. In addition there will be defense project managers in charge of major Government projects, the size and importance of which warrant such special attention.

IT is fully believed that this consolidation of the administration of all defense activities under one head is an important step forward, and will be of great benefit to the Government and to our company.

The company considers its participation in national defense to be of prime importance and is making every effort to serve the Nation well in peace and, through industrial mobilization planning, to be prepared to serve it efficiently in time of war.

"In this modern, scientific world, industrial preparedness is a particularly potent weapon for peace. It is our industrial might and know-how which a potential enemy fears much more than our manpower. Therefore, it is only common sense to make plans to harness our industrial power with maximum efficiency and to make no secret about the fact that we are doing so."

Trends in Preparedness

In today's unsettled world it is important for the United States to preserve its task forces of trained technicians and to prevent the deterioration of production equipment through enforced idleness

William J. Meinel

Heintz Manufacturing Company, Philadelphia, Pa.

This paper was presented by Mr. Meinel at the Industrial Preparedness Seminar of the Thirty-seventh Annual Meeting of the American Ordnance Association, held in the Fairmont Hotel, San Francisco, Calif., May 10, 1955.

MOST active American industrialists are more or less familiar with past and present trends in industrial preparedness. However, when we consider the future of such trends and the direction in which we believe they are going—or should be going—then there is room for timely discussion.

What we in the Heintz Manufacturing Company have found to be practical for our own organization I would like to pass on for whatever value it has to industry and the services.

Our company continually has tried to find those particular needs of the Government which fit most closely our own skills and equipment. We believe we have acted in the best interests of the Government by offering our existing abilities and facilities, together with our permanent personnel, to the preparedness program, and it has been our hope that only supplemental equipment need be added.

IN this manner we feel we can maintain a plant force trained and ready to step into any emergency without delay as well as provide facilities which serve to reduce public expenditures.

In those instances where supplemental equipment is essential, wherever possible it should be either general or multipurpose. We believe that the attendant right to commercial use of Government-owned facilities is essential to maintain our domestic economy and to assure adequate safeguards for possible all-out industrial mobilization.

I would like to reëmphasize our feeling that special-purpose equipment does not constitute the best use of public funds under any but the most exceptional circumstances.

As we all strive in our basic task of making aircraft fly faster and farther, producing more effective weapons, and building swifter surface and undersea ships, we must at the same time keep costs from soaring into the stratosphere.

In order to assure that our Government agencies make the greatest use of existing facilities and to prevent unnecessary flow of Government funds into specialized equipment which, due to product improvements and changed demands, can become obsolete or surplus overnight, I offer the following suggestions and a few examples.

Some of the difficulties inherent in this complex problem might be minimized by making full use of mobilization planning. By this I mean the full utilization of industrial planning groups within the services.

At the same time I would suggest that the product-design people of our services should be among the first to use these planning groups. This is not said in the spirit of criticism. It is a problem that all of us in industry have had to wrestle with on many occasions. We have learned from hard experience that unless we achieve coördination between our design engineering groups and our manufacturing departments that costs and delays can impede progress.

THIS same problem when it is unsolved in so complex a structure as our defense program can seriously affect the national safety in times of emergency. Unless there is an increasing partnership between industrial planning groups and designers, the tendency to bring forth special-purpose tools of short-time usefulness will continue.

During the critical months after we entered the Second World War, Heintz took on a great number of research and development programs. From January 1944 right to the end of the war, they averaged more than one a week. More than twenty-five of them were on machine-gun mounts.

I recall many instances in which original designs called for special machine tools not in our existing facilities. We were permitted to redesign to

pressed-metal specifications so that we could manufacture with the facilities available in our shops. We accomplished this with savings in time and substantial savings in cost.

It should be pointed out that our designers used standard parts wherever possible for each individual component, as well as standard machine tools and established production methods. They knew what was available and suitable to produce the finished product so that it would meet the functional requirements of the ordnance items. Little capital went into anything but jigs, fixtures, and expendable tools.

These were nearly all mass-production jobs. We made approximately 200,000 of the M63 gun mount at a price near $60. This was some eighty-five or ninety per cent less than the M2A1, which it completely superseded.

IN addition, we carried on a sizable research and development program on rocket launchers, ranging from the T21 to the T91. The big 60-tube rocket launcher, nicknamed "Calliope," which was mounted on the medium tank, was designed by us, and prototypes were delivered in six weeks. Production of about 1,000 followed. The only artillery-type rocket launcher which saw service in Korea was our wartime T66, the last of which we built in 1945.

No special production machines were called for in any of those designs. You may say these were simple jobs—they were. But they were made so by simplified design geared to simplified production methods.

More current examples are jet engines and missiles. Wartime experience gained by practical, down-to-earth, experimental design engineers and an augmented staff trained by these technicians enabled the company to assist in the development of low-cost methods of producing these new sheet-metal engine bodies and other subassemblies.

Some of these assemblies have a fantastic combination of strength and lightness, yet are resistant to almost unbelievable physical and thermal stresses. They are currently in high production on what, for the most part, is general-purpose equipment.

The same manufacturing facility can accept the assignment of a great variety of tasks, both military and commercial.

The technique of cold extrusion of steel, which we introduced and spearheaded in this country, is today in general acceptance and is a shining example of a development which will serve the armed forces effectively and make possible improved production results on commercial items.

This thought in particular I would like to emphasize: Wherever possible business leaders should seek Government production which most nearly parallels their experience and plant facilities in the commercial field.

There are many instances in which organizations instituted sizable programs not only completely foreign to their personnel but also unsuitable for the facilities in general use on their commercial work. As a result, new facilities were created to meet the emergency requirements of the Government. When the emergency was over, there was little or no commercial use for many of these plants.

Management has little interest in maintaining an idle plant, and many of them were dismantled after World War II. Within a few years, when the United States was called upon to play a major part in Korea, it was found necessary to build duplicate facilities.

Should Uncle Sam find it necessary to tap us on the shoulder and ask us to move in quickly on ordnance requirements, we can do a more outstanding job if most of our facilities and personnel are prepared to direct their attention promptly to the Government's needs.

This will be possible if we exercise great care in the services we undertake for the Government.

At this point I should like to suggest to the tool industry that it avoid seeking to limit the use of Government-financed equipment to Government work. I feel strongly that such a practice would be a shortsighted policy from a sound business viewpoint and a needless drain on public funds.

May I emphasize that I believe the regulations covering rent to be paid to the Government for commercial use of Government machines are well designed to protect both the taxpayer and free enterprise. Any denial of this permission would be costly to the taxpayer and would retard commercial development to the detriment of both industry and Government.

In these days when the specter of global war haunts the world, it would be disastrous for us as a nation to permit the deterioration of production equipment through idleness. It is even more important that we preserve those task forces of trained technicians and workers so vital to our national security and economic health.

Anything that inhibits full commercial use of Government-owned plant equipment when not in use on Government jobs is, in my opinion, poor planning. It prevents the continued development of commercial know-how which our leaders constantly declare to be of such extreme value to our national defense.

I think all of us remember only too well some of the heartbreaking experiences we had in swinging into defense production at the outset of World War II. I believe, too, that history records that too long a time elapsed before our Nation's productive capacities were geared to the military needs of the Korean situation.

We have come to realize the vital importance of preparedness in times of peace. It has long been a contention of mine that our national defense and the preservation of our free-enterprise economy could be assisted tremendously if stockpiling were practiced on a wider basis than at present.

IN this light, I would like to cite as an example our shipbuilding program as a most important and vital arm of our Nation's defense. When needed in times of national emergency ships have to be built quickly.

While industry's performance in the past has been remarkable in this respect, it should be noted that the overall cost of labor and materials, together with the cost of trainee programs could be greatly reduced if the many standard components going into ship con-

struction were manufactured in peacetime when skilled labor is not only available but cheaper and materials cost less.

Those of us who have served the Navy recognize that the nature and location of a war determine the number and types of ships required. We also understand that this cannot always be predetermined.

NEVERTHELESS, I believe that there are many ship components that are not only standard but which will perhaps always be required on a ship with little or no change in design, except as made necessary by mass production.

Among such items are doors, hatches, manholes, scuttles, airports, and ammunition (ready-service) lockers, etc.

It is my understanding that the Navy Bureau of Ships has recently initiated a program of standardizing the existing design of many components and is considering in such design the interchangeability of hardware as well as the economies to be achieved in line production.

At present there is no appreciable reserve immediately available that could be drawn upon to meet deliveries required for replacements for the fleet. Nor, I am told, are such reserves available to expedite current or contemplated new construction or conversions.

Peacetime stockpiling of these components would help to accomplish the following: Maintenance of skill and know-how; creation of a reasonable reserve of standard units for rapid delivery; the use of materials readily available in peacetime but at a premium and usually under controls during a national emergency; more rapid construction despite late changes; greater stability of employment; and the preservation of small industry.

These various suggestions are presented not as new ideas but with the firm belief that now is the time to carry forward these considerations to their maximum degree.

It is our sincere belief that a need exists for such a stockpiling program and that such a program would be in the interest of our national defense.

During World War II America became known as "the arsenal of democracy," but we were able to rely on our friends and allies to hold the European line while we readied for supporting action. Today our leaders tell us things have changed, and I am sure that we are all more than inclined to heed their warnings.

Today the defense line of the free world is still in Europe—only now it must be manned and equipped for instant action. It has been pointed out recently that if our European partners are to have supplies in anywhere near the tremendous quantities needed in modern warfare, then we must have production rolling in Europe.

The last war showed that heavy production equipment is really hard to knock out. Transportation is much more easily disrupted. With only a few new type bombs, docks in European harbors can be made useless quickly and easily.

All this adds up to the expressed policy of military planners to get production facilities rolling in strategic locations in the free nations—to get them to be self-sustaining and continuous in operation and permanent in nature. This, we are told, is of immediate importance.

The strength of the free nations is also our strength and perhaps the one hope in this disturbed globe that might establish a firm base for peace. I know that I do not have to dwell here on the vast importance which industrial development means to raising living standards and the vital bulwark which this provides against the insidious psychological warfare of the Kremlin.

It is my hope that all of us will heed our great leader and Commander in Chief, President Eisenhower, in his recent plea for strengthening our Mutual Security Program. Speaking before Congress on April 20th, the President asked private industry to join with the free peoples of the world to assist them in building their private industry.

I believe this is a call we can ill afford to neglect. It is of particular importance in those underdeveloped areas of Asia which are free of the Communist yoke. This phase of mutual assistance, the assistance which industrial leaders can provide to other lands, is a definite new trend in industrial preparedness. It partakes of the global view, a view which is essential for the preservation of our own national security in the atomic age.

We in American industry have achieved great satisfaction in our domestic accomplishments. Perhaps there is even greater satisfaction in store for us in the accomplishments we can make on a global scale.

At Heintz, we have had some experience in training and working with European technicians and workers. We have been happily rewarded when we shared our know-how with these fine people. We stand ready to do more of it. We suggest this as a contribution for others to make in the preservation of peace and security.

If present-day American business can hold to the wholesome principles which have made us strong—the simple concept of doing a straightforward, full day's work for ourselves with some capacity left to help our neighbor—then we can keep the trend always toward a stronger America and a better world.

Industry must be ready to mass produce arms and ammunition (Army photo).

Month by Month: Highlights of the National Defense

R.O.T.C. in Science

Dr. Arthur Flemming, director of the United States Office of Defense Mobilization, recently announced that a scientific and engineering Reserve Officers' Training Corps to help conserve the technical talent on college campuses is under consideration by the Department of Defense.

> *The new program, Dr. Flemming said, would mean that a student who had aptitude and ability in the science and engineering fields would get additional training through military service. Instead of having his career broken by entering the Army he would continue with his scientific or engineering work.*

"We would be utilizing his talent in that area, not only while he is in college but after he leaves and goes into military service," Dr. Flemming declared. "It would also provide him with the additional financial help that he would get by being a member of the R.O.T.C."

Dr. Flemming explained that under this proposed program it would be possible for a student to go into an arsenal or laboratory after he had completed his college work. In a sense the program would be comparable to what is now being done to train doctors and dentists on the college level.

We think the Flemming plan has merit. First of all, the national shortage of engineers is growing even more acute. The Engineering Manpower Commission estimates the 1955 addition to the talent supply at 24,000. Against this, it calculates the total 1955 need for new engineers, military and civilian, at between 45,000 and 70,000. This alone indicates a shortage of at least 20,000 engineers and perhaps twice as many.

Furthermore, the experts tell us that many engineers are being wasted in nontechnical Army jobs. Some of the eighty engineers drafted from one oil company refinery in the past year are now GI clerks and typists.

All friends of the Army R.O.T.C. are distressed by the turn of events in that category. Ordnance units of the R.O.T.C. are being closed down outrageously. Soon there will be none left in our schools and colleges. And this at a time when there should be more Ordnance units.

> *In an age of specialization, and when some military leaders refuse to see the light, there seems to be no other alternative but to train a sufficient number of specialists along some such lines as Dr. Flemming suggests.*

While we are debating the problem the Russians are already turning out over 50,000 new engineers a year. And the Reds are expected to increase the figure. Better wake up, America!

The Importance of Nike

The Army, always a vigorous champion of the Nike antiaircraft guided missile, is encountering public relations difficulties at the community level because some people do not want what they consider a dangerous weapon in their back yards.

> *Brig. Gen. R. R. Hendrix, who commands the vital antiaircraft defenses of Washington, recently asserted that "Nike is capable of outmaneuvering and destroying any type aircraft presently known and foreseeable for the immediate future."*

He denied categorically that Nike constitutes an ever-present danger to civilian communities.

"The Nike site is not dangerous," he said, "but is as safe as a gas station, as important to security, and as much a part of the local community as the police and fire departments."

The Army continually emphasizes safety precautions in moving the 20-foot-long missiles and boosters weighing over a ton from reënforced-concrete storage facilities twenty-four feet underground to launching racks for use against enemy aircraft.

Nike is effective against modern aircraft and is a reliable weapon to help defend our cities and strategic areas against the potential holocaust of modern war. Its range would not result in hits directly over target areas.

General Hendrix expressed the hope that the public, once made aware of the importance of Nike to national security, would be more inclined to cooperate in the expanding antiaircraft defense program.

"The Army is very much aware of the impact on communities of installing this new weapon in their back yards," General Hendrix said. "In acquiring Nike sites and, later on, after your soldiers occupy these sites, we are most anxious to intergrate ourselves in the community's daily life with the minimum of inconvenience to the people of that area.

"In short," General Hendrix asserted, "we want to be good neighbors and we hope the community will think of us in that light."

> *A Nike site occupies about fifty acres. Total cost for each Nike installation is about a million dollars. Authorized strength for each Nike battery is 6 officers, 2 warrant officers, and 101 enlisted men.*

Practice firings do not occur at the Nike sites but are held once a year for all battery crews in the Fort Bliss-White Sands area. As an additional safety measure the Army has developed a booster that will disintegrate in the air. If you have Nikes for neighbors give the officers and men a helping hand. They are friendly—not hostile—Nikes!

Navy Nuclear Power School

Early next year the Navy will train officers and enlisted men in the basic theory of nuclear power.

The first class of students is expected to convene in January 1956 at the U. S. Naval Submarine School, New London, Conn. They will be needed in the Navy's expanding nuclear-power program.

Students will first attend a basic nuclear-power course of instruction. Thereafter, new courses will meet every six months. Upon completion of the basic course, students will be reassigned to the appropriate land prototype reactor for practical operator training.

> *The Navy's existing programs at Idaho Falls, Idaho, and West Milton, N. Y., will draw only upon men who have qualified in conventional submarine operations.*

At present, the civilian plants are training officers and enlisted men as replacements for the NAUTILUS and SEA WOLF crews. Some of those now assigned to existing training courses will be reassigned as staff members to presently planned Nuclear Power Training Units at the sites of the land prototype reactors and to the U. S. Naval Submarine School.

In another move to broaden its nuclear power program, Navy Secretary Charles S. Thomas recently directed that a commanding officer be assigned to the Idaho Falls and West Milton plants.

The mission of both officers will be to provide training of naval personnel in the operation and maintenance of nuclear power plants and to furnish personnel to operate the land prototype reactors.

Ready Resources

Victory in any emergency might well depend on how carefully we conserved our national resources.

This prediction was made by Maj. Gen. Roger Browne, commanding the First Air Force, in opening a 2-week national resources conference arranged by the Industrial College of the Armed Forces in New York.

The college is sponsoring a series of similar conferences throughout the Nation for civilian and military leaders. They are a condensed version of the 10-month course given at the college and have been well received by business and industrial executives everywhere.

General Browne said there was need for a rehearsal of the industry-military team in terms of immediate mobilization of men, material, and production for a national emergency. He expressed the view that the struggle for an adequate defense must be accompanied by a determined campaign for frugality and husbanding of our resources.

Comparing Communist methods and aims with our own, General Browne said:

"They erect iron curtains to exclude progress and behind them ration the remnants of a self-limited economy whose greatest problem is how little it can give its people without inciting uncontrollable rebellion.

> *"We seek new avenues of trade and communication in order to share the abundance created by an economic system whose most pressing problem is surplus products."*

General Browne cited these as major factors in the quest for technological leadership: realization that the Nation's resources are not unlimited; that expense must be considered in planning and development; that defeat of our potential foe would require the total mobilization of the Nation's wealth, resources, and productive capacity; and that our resources must be on hand should the blow come.

"We can neither depend upon a foreign source of supply," he declared, "not hope ever again to have the time for marshaling our resources."

Older Weapons Obsolete?

Nuclear weapons were exploded at Eniwetok in 1952 and in the Marshall Islands in 1954. These weapons were many hundred times more powerful than the atomic bombs which were used at Nagasaki and Hiroshima in 1945.

There are no technical or scientific limitations on the production of nuclear weapons still more devastating.

> *Recent tests have proved the feasibility of manufacturing small or limited-yield weapons that can use fissionable material more economically than any hitherto available.*

They have also proved the feasibility of constructing atomic weapons of very small size to fit into a 4- or 5-inch shell, for example, or into the warhead of an antiaircraft or air-to-air guided missile.

Considerable progress has also been made in the reduction of size and bulk of atomic and hydrogen weapons. A hydrogen weapon with a megaton (million-ton) yield, which can be carried by a single-seater fighter-bomber, is now in prospect.

A question of major importance is whether these new developments make older conventional weapons obsolete.

The view of the British Ministry of Defense is negative. The British Army is deployed in many parts of the world —Malaya, Kenya, the Middle East. In these areas conventional forces and conventional arms are required.

> *The Communist world also maintains a great preponderance of conventional land forces. The Soviet Union and her Eastern European satellites have some six million men under arms backed by enormous reserves.*

The presence of a firm shield of troops and tactical aircraft under British and American commands reduces the danger that the Communists might be tempted to try to overrun Europe with conventional troops in the hope that the West would refrain from using nuclear weapons in its defense or that it could be used as a pawn in a shameful negotiation.

The British Minister of Defense informed Parliament last February that "strategic implications of the thermonuclear weapon do not radically alter the rôle of the three fighting services."

Our British friends have wisely refused to accept the doctrine that there is an easy and quick way to victory in war.

American Marksmanship

Army Ordnance is actively fostering good marksmanship! The men who make the rifles are leading the way toward their effective use.

The First Annual Post Commanders' Small Arms Tournament of the Army Ordnance Corps was held recently at Aberdeen Proving Ground, Md.

Good weather, coupled with the skill of the marksmen and range personnel, made the tournament move smoothly and established it firmly as a popular annual event.

Following the tournament a banquet was held for the purposes of presenting awards to pistol and rifle champions. Awards were made to the top two teams in the pistol phase and the top three teams in the rifle phase.

The awards were presented by Maj. Gen. J. L. Holman, commanding general of Aberdeen Proving Ground.

Staggering Losses

By June 30th the Armed Forces had lost four out of every ten enlisted men who were on active duty at the start of the current fiscal year.

> *According to Defense Department estimates, the 40 per cent loss will represent more than 1.1 million enlisted men.*

The over-all reënlistment rate for Regulars in the first half of fiscal year 1955 was 24 per cent—less than half the average level of fiscal years 1950 to 1953. The Defense Department stated that the major factor accounting for the high turnover rate was that few first-term personnel signed up for second tours of duty.

While preliminary reports for the closing months of 1954 revealed some improvement in reënlistments for Regulars, particularly in the Army, Defense Department officials said that it is too early to measure the effect of the reenlistment bonus.

Although all services have been faced with the problem of high turnover rates during the past few years, variations in terms of service for new personnel in each service account for the differences in replacement cycles which followed the large input of enlisted men during fiscal year 1951.

It is expected that the new pay bill, granting eight to fifteen per cent increases, will do much to cut down the high turnover rate.

It is serious business, this lack of interest by young Americans in the military service as a career. Could it be a sign of growing softness?

Whatever the cause, there is added ground for concern about the way trained career men are forced to retire while at the very height of their usefulness and young men—their replacements—are not staying on. How about holding on longer to the experts!

Underwater Device

The Department of Defense and the Atomic Energy Commission announced recently that "the underwater explosion of a small nuclear device in the Eastern Pacific Ocean has been successfully completed by Task Force 7."

The Government gave no details and said "no further announcement will be made concerning the military results of the experiment."

> *In announcing the test on May 9th, however, the Defense Department stated it was designed to help perfect a defense against submarine attack.*

Our Navy has decided to step up its atomic submarine construction program because of the success of the NAUTILUS. Adm. Robert B. Carney testified before a joint Congressional subcommittee that the NAUTILUS has proved successful beyond all expectations.

Navy will revise its budget estimates for next year to include four atomic submarines instead of three and now plans eight atomic submarines in all. It will cut its request for conventional submarines next year from five to four.

The underwater blast, according to the May 9th announcement, involved no health hazard to mainland or island inhabitants or consumers of fish.

Experts surmised that the weapon was a device that could be dropped or fired into the sea and exploded at a desired depth. Whether it was a guided missile, torpedo, depth charge, mine, or bomb was not disclosed.

Tests at Yucca Flat

Nuclear weapon testing near Las Vegas, Nev., is providing valuable opportunities for the indoctrination of military personnel.

As many soldiers, sailors, Marines, and airmen as possible are ordered to Yucca Flat to witness the spectacular power of nuclear explosions.

This psychological conditioning is important to military personnel to accustom them to the use of nuclear weapons. Experts maintain that the general awe in which these fearsome weapons are held could be a dangerous psychological factor on the battlefield without previous familiarization training.

All military observers are given a chance to see for themselves that nuclear weapons are not "absolute" in power.

> *It has been found by direct personal experience that earth and steel provide good protection against blast, heat, and radioactivity, even close to the explosion.*

Volunteers occupy trenches only a few thousand yards from the explosion. Yet they have found ample protection in reënforced trenches six feet deep.

Farther back, at 3,500 yards, the bulk of military observers are protected by 4-foot trenches reënforced with sandbags.

The Army is also testing a great variety of equipment and weapons exposed to nuclear blast. And for the first time in nuclear testing men will actually be in tanks exposed to nuclear blast.

> *Three unmanned M-48 tanks have survived six previous nuclear blasts and are still in good running condition.*

It is now thought that armor, because of the protection given to soldiers, and particularly because of its mobility and capability of exploiting rapidly the shock effect of nuclear weapons, will be of tremendous importance in any nuclear war in which ground troops participate.

In this regard, Capt. John C. Burney, Jr., in an article, "Armor for Atomic War," which appeared in the May-June 1955 issue of ORDNANCE, stated:

"For maximum effectiveness, tactical atomic weapons should be used in close coördination with ground forces. Our combat units must remain far enough from ground zero to avoid friendly casualties but must reach the target area as soon as possible after the detonation. Only highly mobile forces can properly exploit the use of atomic weapons."

Our Government Arsenals

An Editorial

THE Commission on Organization of the Executive Branch of the Government, headed by former President Hoover, is currently making recommendations for economy and efficiency in governmental operations which, if put into effect and properly implemented, would save billions of dollars of taxpayers' money and strengthen the entire economic structure of the Nation.

The Hoover Commission is seeking to prevent waste and duplication, to lower operating and maintenance costs, to achieve accurate determinations of requirements and, wherever possible, to take government out of costly and unnecessary competition with private industry.

The Commission believes that its recommendations, if adopted, could save the United States more than $150 million of its annual $3 billion transportation bill and more than $340,000,000 a year in Federal food and clothing bills.

When the twenty-odd task forces set up by the Hoover Commission to study and recommend streamlined functions of the Federal Government complete all their recommendations, the estimated savings to the American taxpayer would be $6 billion and, in addition, the Treasury could recapture another $7 billion now spent on services that private industry, rather than government, could provide.

The Hoover Commission is doing a remarkably fine job in carefully scrutinizing the multitudinous operations of the many bureaus and departments of our Federal Government which, in the aggregate, constitute the biggest and most complicated business in the world today. Those who are participating in the valuable and constructive work of the Commission are men of the highest competence and integrity, and their suggestions and recommendations are the fruit of objective and painstaking survey and analysis.

Although many of the Hoover Commission reports are critical of current operating procedures—and rightly so—the Commission "neither suggests nor subscribes to any proposal that might impair ever so slightly the military effectiveness or the reserve strength of the Department of Defense." The Commission very wisely implies that our arsenals and gun factories as operated over the years by our Army and Navy, are unique in character and function. These are not large enterprises, but their value to the Nation, in peace and war, is incalculable.

The primary job of these small establishments is to keep the art of ordnance design and production alive when private industry is engaged for the most part in the production of peacetime goods.

ORDNANCE design and manufacture is one of the most highly specialized professions in the world today. Private industry alone, without arsenal and gun-factory know-how, could not have mass-produced nearly so quickly the weapons and ammunition that were essential to victory in World War II. Ordnance of the future will be essential to victory in any conflict in which the United States may be involved.

The transmission to private industrial plants of the priceless know-how depended ultimately upon arsenal and gun-factory personnel. They are that small group of patriotic and dedicated men—in uniform and in mufti—who, regardless of personal financial sacrifices during the lean peacetime years when manufacturing orders for our small peacetime Army, Navy, and Air Force were few and far between, nevertheless remained true to their professional calling. They kept alive the art of munitions manufacture and passed on to American industry, in a truly desperate hour, the methods, skills, and techniques that were initially required to produce the land-sea-air armament of our own forces and our allies. Their availability in two World Wars gave all of us another and perhaps a final opportunity to build a better, more cooperative, and more peaceful world.

IN the postwar era our arsenals and gun factories have continued to serve as training schools for our Regular officers and for our Reserve officers when they are called for brief periods of active duty.

During the fretful and uneasy years of so-called peace, our arsenals and gun factories, in addition to preserving the science of armament manufacture, have carried on various types of forward-looking scientific research work necessitated by the successful application of atomic fission to military purposes.

Our arsenals and ordnance plants have been an indispensable source of strength in every war in which we have been engaged.

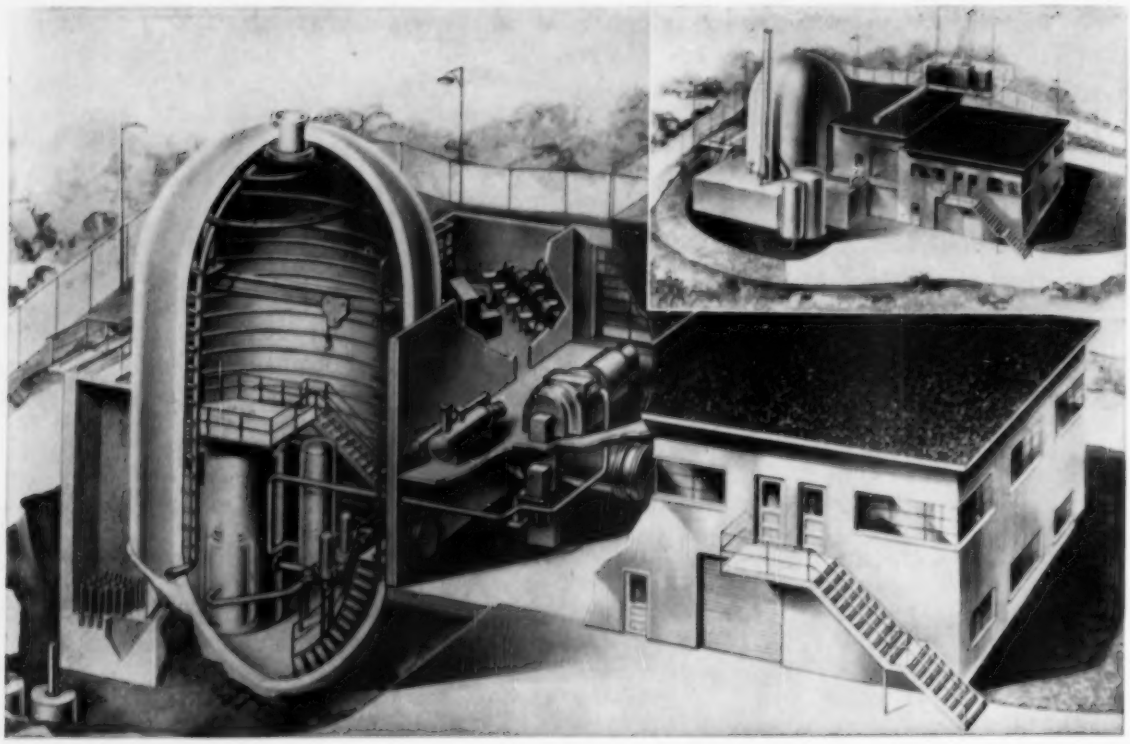
Gunsmiths in the vicinity of Springfield, Mass., were repairing and fabricating muskets prior to the American Revolution. During the Revolution, Springfield made cannon and repaired muskets and other ordnance matériel. After the war, Congress authorized the establishment of a national armory at Springfield. The armory's total production from 1795 to the advent of the world-famous Garand in 1937 was 3,887,749 small arms.

Watervliet Arsenal was founded in 1812, Frankford Arsenal in 1815, and Watertown Arsenal in 1816. Rock Island Arsenal had its origin in Civil War days in 1863, while Picatinny Arsenal was founded in 1879. The Washington Navy Yard became a gun factory in 1883.

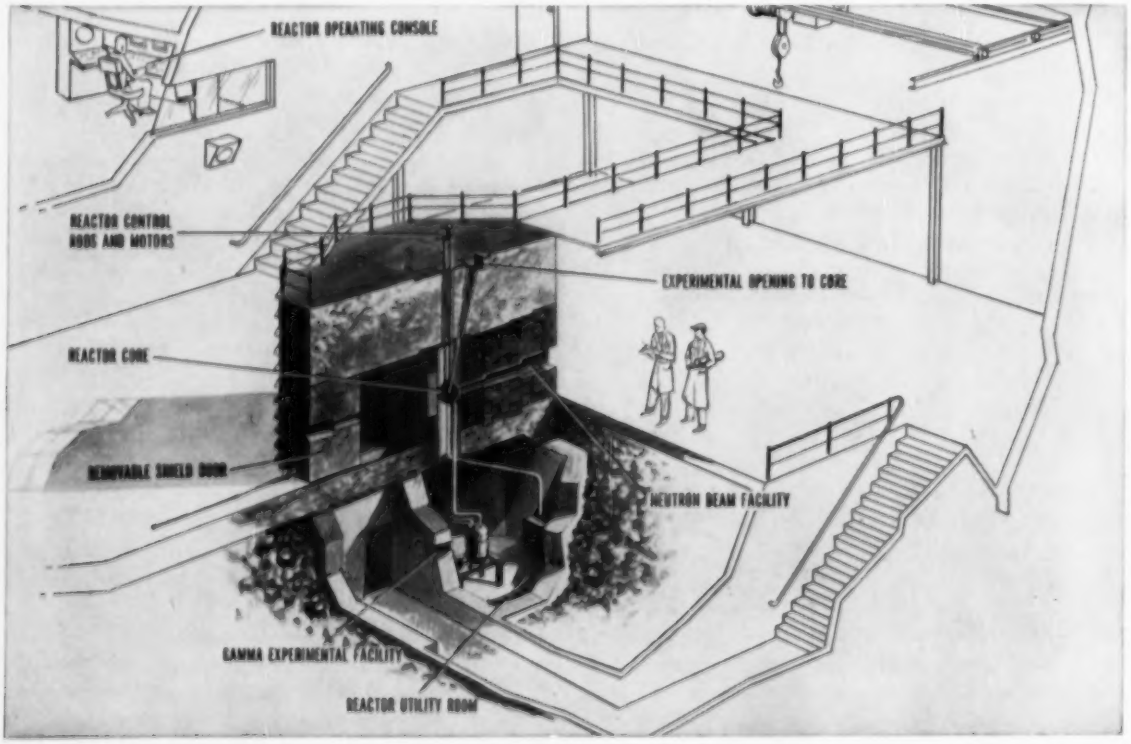
The importance of all our Army-Navy arsenals and gun factories was brilliantly emphasized by Maj. Gen. C. C. Williams, Chief of Ordnance in World War I, in the following memorable words:

"The arsenals are an extremely important part of our preparedness program, for it is through them mainly that the art of munitions design and manufacture is perpetuated. They are to war munitions production what the Regular Army is to war manpower."

For Atomic Research



The views above show the Army package power reactor designed by American Locomotive Company for the AEC. It will be erected at Fort Belvoir, Va., and completed in about three years. The sketch below shows the first nuclear reactor for private industrial atomic research being designed and built for Armour Research Foundation, Chicago, by North American Aviation, Inc.



ASSOCIATION AFFAIRS

Philadelphia Post Tours River and Holds Meeting Aboard Steamboat

The Philadelphia Post called out all its seagoing members for their annual meeting aboard the Wilson Line steamer STATE OF PENNSYLVANIA on May 25th.

About 500 members reported on board at 9:30 a.m. for a full day devoted to industrial preparedness and Post business. This year the Post steamed south down the Delaware River on a trip emulating last year's trip north to visit the Fairless Steel Plant.

Sailing down the Delaware, the tremendous industrial strength of the Philadelphia area was displayed impressively. The steamer passed petroleum refineries, shipyards, chemical explosives plants, transportation centers, and manufacturing complexes in endless succession as an announcer kept the "voyageurs" informed of the contribution each plant makes to national defense. A special 3-blast whistle salute was accorded the Scott Paper Company whose representatives had given so generously of their time to sponsor the program.

Early in the trip the steamer slowed abreast the Naval Base while the announcer explained the facilities visible at the Naval Aircraft Factory and the Naval Shipyard and briefly described the status of conversion or repair work under way on the large assortment of naval vessels berthed there.

As the turning point drew near, all hands were treated to a buffet lunch followed by an impressive series of close-formation flying tactics "layed on" by F-89 interceptors stationed at the New Castle Air Force Base.

While the steamer worked back up the river, William H. Worrilow, Sr., Post president, presided at the annual meeting where nominations for directors and officers were announced and approved.

Dr. R. L. Johnson, president of Temple University, the guest speaker, talked informally of his experiences in reorganizing the United States Information Agency and delivered a strong appeal for support of our counterpropaganda program.

Brig. Gen. David N. Hauseman was awarded the John C. Jones Medal for his many years of loyal support of his country in his judicious and helpful handling of the many industrial problems incident to production for World War II ordnance while he was chief of the Philadelphia Ordnance District.

With the Post's business completed, all hands gathered aft on the main deck for welcome refreshments.

YANKEE POST VISITS CAMBRIDGE RESEARCH CENTER AND HOLDS DINNER MEETING

The Yankee Post met with the Air Force at Hanscomb Air Force Base, Bedford, Mass., on Tuesday, April 5th. A large number of the New England Ordnance fraternity were on hand to tour the Cambridge Research Center of the Air Force and attend the dinner.

Starting in midafternoon, the early arrivals toured the Electronics and Geophysics Research Divisions where samples of the work of these activities were on exhibit. On the flight line, the members saw a static display of aircraft and were treated to flying displays by helicopters and jet aircraft.

At the dinner meeting at the Officers' Club where Charles B. Weeks, Post president presided, an honorary membership was presented to Maj. Gen. Raymond C. Maude, commanding officer of the Cambridge Research Center at Hanscomb. A briefing team from the Center described its operations and presented a short film on Air Force research activities.

Shown above, left to right, are members of the San Francisco Post's committee which made arrangements for the 37th Annual A.O.A. Meeting in May: A. B. Layton, J. M. Hait, James Moulton, Rear Adm. H. A. Carlisle, A. H. Brawner, Herman D. Nichols, B. C. Heacock, Col. J. M. Stark, Post President L. S. Fletcher, F. B. Whitman, W. E. Waste, C. E. Root, E. R. Peterson, Lieut. Gen. LeRoy Lutes, Maj. Gen. L. C. Ames, and J. H. Patrick. The group met at the Pacific Union Club in San Francisco.

Maj. Gen. J. V. Crabb Tells Quad Cities-Iowa Post about Continental Air Defense

The spring meeting of the Quad Cities-Iowa Post was called to order by the president, P. S. Mumford, following a dinner served in the Rock Island Arsenal Post Restaurant on April 22nd.

Mr. Mumford introduced Col. A. R. Cyr, commandant at Rock Island Arsenal, who welcomed the members and assured them that the arsenal would continue to be of help in A.O.A. activities.

The mayors and civil-defense directors of the Quad Cities area who attended this meeting were also introduced and acknowledgment was made of an award which had been presented to the Post by the Reserve Officers' Association of Rock Island County and Davenport for participation in the annual observance of National Defense Week, 1954 and 1955.

The new officers for 1955-1956 were introduced from the floor by the chairman of the nominating committee, George Uhlmeyer, as follows: Maurice A. Fraher, president; Clay E. Murray, vice-president; and Donald L. Meyers, secretary-treasurer.

The principal speaker was Maj. Gen. J. V. Crabb, Commander, Central Air Defense Force, who spoke on "Continental Air Defense."

General Crabb outlined the build-up of the Air Defense Force during the past ten years, pointing out that it was a joint effort of the Army, Navy, and Air Force and the civilian population. He noted that the defense of this country must be incessantly available since it appears certain that any future wars will strike here first.

Air defense of this continent will include territories both of the United States and Canada, and presently consists of radar network chains extending across the most vulnerable areas supplemented by a civilian ground observer corps reporting directly to central air bases.

Rear Adm. F. S. Withington Addresses Meeting of the Capital Cities Post

The Capital Cities Post annual meeting took place on Thursday, April 21st, at the Edison Club, Schenectady, N. Y. Post President Earl D. Rhodes of F. C. Huyck and Sons opened the meeting by receiving the reports of the chairmen of the various standing committees who were all commended for their outstanding accomplishments in promoting the interests of the Post throughout the year.

He announced the results of the recent election in which W. C. Elcan, General Electric Company, was elected president. Other officers are Vice-Presidents Col. E. S. Mathews and E. B. Doherty; Secretary-Treasurer P. F. Biglow. New directors will be Prof. A. A. K. Booth, E. S. Webster, and E. M. Ashworth.

Vice Adm. W. A. Kitts, 3rd, a former Post president, introduced the guest of honor and speaker for the occasion, Rear Adm. F. S. Withington, Chief of the Navy Bureau of Ordnance. Admiral Withington discussed the operations of the Bureau—what he and his staff are trying to accomplish and what is being done. The Admiral summed up his job as one of keeping the Navy ahead of our potential enemies and emphasized that this job was a "sobering responsibility."

Shown above at the Capital Cities Post meeting are, left to right: Capt. J. M. P. Wright, A.O.A. staff; Vice Adm. W. A. Kitts, 3rd, a past president; W. C. Elcan, president-elect; Rear Adm. F. S. Withington, Chief, Navy Bureau of Ordnance; E. D. Rhodes, retiring president; and John Wyld, Post publicity chairman.

DR. T. A. BOYD ADDRESSES ABERDEEN POST MEETING

The Aberdeen Proving Ground Post held its spring meeting on Tuesday, April 26th, under the leadership of Harold D. Duppstadt, Post president.

The guest speaker of the evening, Dr. T. A. Boyd, a consultant to the General Motors Research Laboratories, addressed the members on research and creative engineering in industry. He praised the teamwork in recent years of the research worker, the creative engineer, and the production man who frequently joined forces to perform industrial miracles.

His talk pointed clearly to the serious setbacks we face in further developments if the input to the engineering professions is not expanded.

• **AT CLEVELAND.**—A special luncheon meeting was called on Tuesday, April 26th, to greet the new commanding officer of the Cleveland Ordnance District, Col. J. G. Duncan. Almost 500 members of the Cleveland Post gathered with other civic officials in the Hotel Statler to greet Colonel Duncan who was welcomed by Thomas F. Patton, vice-president of Republic Steel Corporation and a director of the Post. A. J. Weatherhead, Jr., Post president, was host, and J. E. Trainer, Post vice-president, was chairman of the meeting.

Brig. Gen. J. B. Medaris, chief of the Industrial Division in the Office of the Chief of Army Ordnance, the principal speaker, discussed the status of the Army's defense program.

PHILADELPHIA POST OPENS CHAPTER AT LEHIGH U.

The Lehigh University Chapter of the Philadelphia Post was inaugurated on April 13th at Packard Laboratory on the university campus, Bethlehem, Pa. An alert and enthusiastic representation of students from three upper classes in Lehigh's Ordnance R.O.T.C. Unit were on hand under the leadership of their newly elected Chapter president, Cadet Walter J. Bennett.

Maj. Walter P. Cumbie, senior Ordnance officer on the staff, opened the meeting by introducing William H. Worrilow, Sr., president of the Philadelphia Post, who spoke strongly and to the point on the ideals of the A.O.A. and what it means to the country's students. He then presented the new charter to Cadet Bennett.

As presiding officer, the new Chapter president introduced Col. B. S. Mesick, former commanding officer of Watertown

Arsenal, now with A. D. Little Company.

Cadet Bennett also introduced Capt. J. M. P. Wright from A.O.A. headquarters, and Col. A. C. Molter, commanding officer of the Lehigh University R.O.T.C. Both welcomed the students as new members of the A.O.A. and wished them success.

Other officers of the chapter are: John E. Jacoby, vice-president; Frederick A. Moller, secretary; and Augustus M. Filbert, treasurer.

• **AT SHREVEPORT.**—The Louisiana Post held a joint dinner meeting with the Bomb and Artillery Division of the Association on Monday, May 9th, at the Shreveport Country Club. This affair was attended by a large majority of the Post members and a good representation from the New Orleans Chapter.

On May 10th at a business meeting where Post President J. A. Ward presided, the Post members were notified of the approval of their constitution. They also unanimously elected Otto Jank, of Day & Zimmerman Corporation as first vice-president of the Post.

MILWAUKEE POST MEMBERS VISIT CHAIN BELT PLANT

A large contingent of A.O.A. members from the Milwaukee Post and other parts of the country assembled at the Chain Belt Company's Ordnance Plant on March 22nd. The occasion was a ceremony placing the plant in stand-by as the last of over four thousand 105-mm. howitzers, produced since the Korean war started, were shipped to proof.

J. R. Strassburger, plant manager, was master of ceremonies. Among the dignitaries present were L. B. McKnight, president of Chain Belt; Col. E. S. Mathews, commanding officer, Watervliet Arsenal; and Col. Lyman F. Stangel, chief of Chicago Ordnance District.

Shown above inspecting 105-mm. howitzers are, left to right: L. S. Stangel, O. W. Carpenter, and L. B. McKnight.

Puget Sound Post Inspects Air Defense at McChord Air Force Base, Washington

The Puget Sound Post devoted the day of Friday, May 7th, to undergoing indoctrination in air defense of the Northwest at McChord Air Force Base, near Tacoma, Wash. A.O.A. members and guests witnessed its operation and armaments and were host to Maj. Gen. W. E. Todd, Commander, Western Air Defense Forces, at their spring dinner meeting.

Careful planning and split-second timing were in evidence throughout the day as members and guests were guided to key points of interest. They saw exhibits of all air-defense aircraft, their components and accessory equipment, and their rocket and gun armament.

Small groups were escorted to the air-defense control center, radar housings, direction center, the repair and testing docks, and the alert hangar where armed jets are constantly ready for "scrambling" to investigate unidentified radar contacts. Several times throughout the day F-86 Sabrejets were observed streaking down the runway on such missions.

After lunch at the base mess, all hands assembled at the air strip for a demonstration. Here the Sabre Knights, a 4-man flying team in F-86D's, serving with the 325th Fighter Interceptor Squadron, gave a breath-taking performance of close-order precision flying. Air reserve work was simulated by amphibious aircraft and helicopter, and the audience was enthralled as the helicopter pilot performed a close approach to a loop—a difficult maneuver for a rotor-winged craft.

Following this full day at the base the crowd assembled at the Officers' Club for refreshments and the dinner meeting. Joseph A. Denn, Post president, welcomed the members and introduced Wellwood E. Beall, senior vice-president of Boeing Airplane Company, the toastmaster.

Don Yates of Seattle and Clinton S. Reynolds of Tacoma greeted the audience in behalf of the Chambers of Commerce of their respective cities, and Capt. J. M. P. Wright made a report from A.O.A. headquarters.

General Todd, the guest of honor, focused the events of the day in his talk on "Defense of the United States against Air Attack."

Among the distinguished guests not previously noted were Brig. Gen. R. W. Puryear, commander, 25th Air Division; Col. H. B. Longino, McChord Air Force Base commander, the host for the day, whose excellent planning enabled the members to observe the many interesting activities; and E. H. Hemb, Standard Service Tire Company, general committee chairman for the Post, who did a splendid job on the over-all arrangements.

Ambassador Patterson Speaks at Luncheon of the Washington Post

The Washington Post was fortunate to have as its guest of honor, Ambassador Morehead Patterson, U. S. Representative for International Atomic Energy Negotiations, at its monthly luncheon meeting on Thursday, April 14th.

Ludlow King was called on by Post President George M. Riveire to introduce Mr. Patterson who presides over the American Machine & Foundry Company in addition to his ambassadorial duties.

Ambassador Patterson talked on "Atoms for Peace." He pointed out that the prospective increase in the world's power requirements in the next few years means new power sources must be established. In matching the availability of petroleum and hydraulic power against the future power needs he made it clear that it would not be the underdeveloped nations, but the industrial nations, particularly in Western Europe, which would first find atomic power an economic necessity.

Other guests at the speakers' table were: Hon. Herbert B. Loper, Assistant Secretary of Defense for Atomic Energy; Hon. George H. Roderick, Assistant Secretary of the Army; Gen. W. Bedell Smith, vice-chairman, board of directors, American Machine & Foundry Company; Gen. John E. Hull, recently commander in chief, Far East Command; Lieut. Gen. L. L. Williams, Army Comptroller; Lieut. Gen. J. M. Gavin, Deputy Chief of Staff for Plans and Research, U. S. Army; Maj. Gen. W. D. Eckert, Deputy Chief of Staff, Material, Air Force Headquarters; Maj. Gen. L. E. Simon, chief of research and development, Office of the Chief of Army Ordnance; Maj. Gen. P. F. Yount, Chief of Transportation, U. S. Army.

Charter Awarded Albuquerque Chapter of Rocky Mountain Post, A.O.A.

The officers and directors of the Albuquerque Chapter of the Rocky Mountain Post met at luncheon on April 25th at the Kirtland Air Force Base Officers' Club to receive their charter which was presented by Brig. Gen. Gilbert H. Stewart, now retired, who has been a member of the Association since October 11, 1923. He was accompanied by his son, Col. C. B. Stewart, deputy commander of the Air Force Special Weapons Center.

Brig. Gen. G. H. Stewart, center, presents charter to the Albuquerque Chapter as Rear Adm. W. W. Juvenal, left, P. J. Hansen, Chapter Chairman Col. C. F. H. Begg, R. H. Watkins, and L. E. Snodgrass, right, secretary-treasurer of the Chapter, look on.

Col. Charles F. H. Begg, Chapter chairman, received the charter in a ceremony witnessed by Rear Adm. A. E. Uehlinger, Rear Adm. W. W. Juvenal, P. J. Hansen, R. H. Watkins, and L. E. Snodgrass. General Stewart in turn was presented with an A.O.A. medal and plaque by the Chapter chairman.

General Stewart graduated from West Point in 1902 and transferred to the Ordnance Department two years later. During World War I he commanded Springfield Armory and later commanded the Hawaiian Ordnance Depot and Watervliet Arsenal. During his long years of service he was graduated from the Army Industrial College and the Army War College as well as serving on the faculty of the Army War College before he retired from active duty in 1942.

St. Louis Post Hears General McCorkle Tell Members about Guided Missiles

Nearly 400 members of the St. Louis Post assembled at the Jefferson Hotel in St. Louis on the evening of March 23rd to hear an address on guided missiles by Brig. Gen. Charles M. McCorkle, Deputy Assistant Chief of Staff, United States Air Force. It was an enthusiastic assembly, significant of the traditional ties in the area between science, industry, and the military.

The Post was founded twenty-seven years ago by the late Col. Harry Scullin, president of the Scullin Steel Company, and for many years chief of the St. Louis Ordnance District.

General McCorkle's address was illustrated with moving pictures and described some of the complex operations required in the assembly of guided missiles.

Col. William P. Gatley, president of the Post, presided at the dinner. Col. Leo A. Codd, executive vice-president of the Association, served as toastmaster.

The following special guests who were seated at the speakers' table were introduced: Wallace A. Morse, executive assistant, St. Louis Ordnance District, and a Post director; Lieut. Col. Glenn J. Harris, executive officer, St. Louis Ordnance District; Henry C. Miller, vice-president, Emerson Electric Company, and a Post director; M. F. Peterson, president, Carter Carburetor Corporation, and vice-president of the Post; Winfield E. Hartford, chief technical products officer, St. Louis Air Procurement District, and treasurer of the Post; W. M. Akin, president of Laclede Steel Company, and a Post director.

Also, Vincent P. Ring, treasurer, Knapp-Monarch Company; Aaron Fischer, president, Universal Match Corporation, and a Post director; Col. Paul G. Dolan, chief, St. Louis Air Procurement District; Irvin L. Jerger, comptroller, St. Louis Ordnance District, and secretary of the Post; Edward F. Judge, president, Scullin Steel Company, and a Post director.

Also, Col. Arthur C. Piepkorn, acting chaplain for the Missouri Military District and professor of systematic theology, Concordia Seminary; Maj. William H. Van Marter, Office of the Assistant Chief of Staff for Guided Missiles, U.S.A.F.; and Vice Adm. Albert G. Noble, Nordberg Manufacturing Company, Milwaukee.

Preceding General McCorkle's address, a business meeting of the Post was held at which officers and directors were elected for the ensuing year.

MAJ. WINSTON R. FROST WINS ALDEN ESSAY AWARD PRIZE

Maj. Winston R. Frost, a native of Cleveland, Ohio, now on duty with the Army Ordnance Ammunition Command, Joliet, Ill., has been awarded the $100 prize for the winning entry in the Alden Scholarship Essay Contest. The winning essay was entitled, "How the Ordnance Corps Can More Effectively Utilize Personnel during Their Two-year Period of Service."

The contest is sponsored annually by the Timken-Detroit Axle Division of Rockwell Spring and Axle Company and the American Ordnance Association in memory of Col. H. W. Alden, an Ordnance officer who was president of Timken-Detroit Axle Company and one of the founders and a staunch supporter of the American Ordnance Association.

Brig. Gen. R. G. Butler, head of the Ordnance Ammunition Command, congratulates Maj. W. R. Frost, winner of the Alden Scholarship Essay Contest.

The contest was open to all military students, officers or enlisted, who received resident or extension training from the major training schools of The Ordnance Training Command, Aberdeen Proving Ground, Md., during the period June 1, 1954, to March 1, 1955.

Hon. Charles C. Finucane Addresses New York Post's Annual Dinner Meeting

Hon. Charles C. Finucane, Under Secretary of the Army, was the guest of honor and principal speaker at the annual dinner meeting of the New York Post at the Hotel Sheraton Astor, New York City, on the evening of April 27th. Nearly 300 members of the Post were in attendance to greet the Under Secretary upon his first appearance before a unit of the American Ordnance Association.

Maj. Gen. Russell L. Maxwell, President of the Post and a vice-president of American Machine & Foundry Company, presided. Col. Lloyd W. Stearns, a director of the Post, was chairman of the Meeting and Program Committee.

Secretary Finucane described the policies of the Army with reference to current Ordnance production programs. He stressed the need for constant readiness on the part of industrial producers and the necessity of keeping an alert stockpile of armament production know-how. He referred in glowing terms to the achievements of the Ordnance Association in the furtherance of industrial preparedness and urged the members to continue their support as a guarantee of the strength required in modern conflict.

Greetings of the Ordnance Department of the Army were extended on behalf of Maj. Gen. E. L. Cummings by Brig. Gen. Joseph M. Colby, commanding general, Frankford Arsenal, Philadelphia, Pa. Col. Leo A. Codd, executive vice-president of the Association, Washington, D. C., conveyed the greetings of Vice Adm. George F. Hussey, Jr., the Association's president, who was detained in the Midwest.

Others at the speakers' table were: Maj. Gen. Roger J. Browne, commander, First Air Force; Brig. Gen. W. H. Colbern, deputy commanding general, First Army; Brig. Gen. James Glore, commanding general, New York Port of Embarkation; Brig. Gen. J. A. Barclay, commanding general, Picatinny Arsenal; Col. John D. Billingsley, professor of ordnance, United States Military Academy; Lieut. Col. John W. Graham, deputy chief, New York Ordnance District, and secretary-treasurer of the New York Post.

Large Contingent of Florida Post Meets at Eglin Air Force Base

The Florida Post had its largest turnout of the season on March 21st with over one hundred members and guests attending the annual meeting at the Shalimar Club, Eglin Air Force Base.

Col. Paul S. Bechtel, Post president, as presiding officer reported on the year's activities. He welcomed the distinguished guests who included Col. John W. Carpenter and Col. Mark Duffy, both from Headquarters, Air Research and Development Command, and Henry Gibson, Radiation Research Corporation, who had flown in from West Palm Beach.

Brig. Gen. E. P. Mechling, commander of the Air Force Armament Center and the Post's national Council member, was toastmaster and introduced the guest of honor, Maj. Gen. John W. Sessums, Jr., vice commander of ARDC.

General Sessums, in his talk on "Air Force Research and Development" highlighted the mission of the Air Research and Development Command and described briefly each of its ten centers.

He then described how research and development, after being given the proper number of skilled personnel and adequate facilities, has made tremendous strides in mobility due to the high speeds attained by our present-day aircraft.

His talk was followed by an ARDC staff film report which highlighted various developments of the Command, such as the B-52, XT-37 jet trainer, an aircraft barrier for stopping jet aircraft, launching of guided missiles and jet aircraft from zero-length launchers, high-speed sled tests of various aircraft components and structures, and personnel ejection tests.

Maj. Gen. John W. Sessums, Jr.

Two weeks later, thirty-seven members of the Florida Post journeyed to the Pensacola Naval Air Station to board the aircraft carrier U.S.S. MONTEREY. At sea they witnessed the qualifying landings by student pilots and were thoroughly briefed in the duties of the flight-deck crews and other carrier operations.

MORE THAN 300 MEMBERS OF THE LOS ANGELES POST VISIT THE NAVAL ORDNANCE TEST STATION, INYOKERN

Over 300 members of the Los Angeles Post journeyed to the Naval Ordnance Test Station, Inyokern, Calif., to join 100 of their Inyokern Chapter members for a demonstration of naval ordnance testing operations on April 15th and 16th.

It was a highly successful venture during which the members camped in tents, witnessed missile and rocket firing tests and aërial demonstrations, and observed many of the routine operations that are carried on at a large test center. They toured the Michelson Laboratory, Aëroballistics Laboratory, some of the air and ground ranges, and the high-speed test track.

Prior to the first inspection trip, K. H. Booty, head of the Engineering Department and Chapter president, introduced Capt. David B. Young, station commander, who welcomed the assembly from Los Angeles led by Robert C. Geffs, Post president. Dr. W. B. McLean, technical director, described the general operation and layout of the station and summarized the schedule of events to follow.

At the dinner meeting in the Community Center where Mr. Booty presided, Brig. Gen. L. I. Davis, commanding general, Holloman Air Development Center, and Dr. W. H. Pickering, director, Jet Propulsion Laboratory at Pasadena, gave the members an insight into the problems in their respective fields.

General Davis described the organization and rôle of the military test centers in guided-missile development and Dr. Pickering related some of the fundamental problems involved in missile development.

Among the distinguished guests were Gen. Omar N. Bradley and Col. W. S. Broberg, formerly in command of the Los Angeles Ordnance District.

The A.O.A. members were pleased to discover that there was a surplus of receipts over expenditures from the meeting amounting to about $350 which was presented to the Navy Relief Society Auxiliary.

Col. Charles Deere Wiman, Long a Director of A.O.A., Dies at Tucson

• **COL. CHARLES DEERE WIMAN,** a director of the American Ordnance Association and president of Deere & Company, farm equipment manufacturers, died at Tucson, Ariz., on May 12, 1955. He was serving his second 4-year term as a director of the A.O.A. of which he had been an active member for many years. He was widely known throughout the Ordnance fraternity and industry for his ability, geniality, and leadership.

A great grandson of the founder of Deere & Company, Colonel Wiman became president of the organization in 1929. He was a native of New York, a graduate of the Sheffield Scientific School of Yale University, and an ardent yachtsman. He served as a 2nd lieutenant and

Col. Charles D. Wiman

captain during the First World War and as colonel on the staff of Lieut. Gen. Levin H. Campbell, Jr., Chief of Ordnance of the Army in World War II.

Known for his participation in ocean sailing races, Colonel Wiman competed in 1947 and 1949 in the trans-Pacific race from Los Angeles to Honolulu.

A founder of the Quad Cities-Iowa Post of the Ordnance Association, Colonel Wiman took an active part in all matters related to the industry-military affairs of Moline, Ill., the headquarters of his company.

He was closely identified with the Rock Island Arsenal where he was a frequent visitor. He was also a director of the Continental Illinois National Bank and Trust Company, the Chicago Rock Island Pacific Railroad, the Hilton Hotels Corporation, and Protection Mutual Life Insurance Company.

He will be deeply missed by his colleagues on the board of directors of the American Ordnance Association as well as by his countless friends throughout the organization who were inspired by his ability and warmed by his friendship.

• **QUINCY BENT,** retired vice-president of the Bethlehem Steel Company and a charter member of the American Ordnance Association, died at his home near Bethlehem, Pa., on May 5, 1955. Nationally known as a leader of the American steel industry he was closely identified with ordnance progress for more than five decades. He began his career at the Bethlehem Steelton plant in 1901.

A graduate of Williams College, Mr. Bent became vice-president of Bethlehem in charge of all the company's steel plants in 1918. He served as chairman of the committee on manufacturing problems of the American Iron and Steel Institute. During the Second World War he was a member of the Steel Advisory Committee of the Army and Navy Munitions Board and served as chairman of two committees of the War Production Board. In 1944 he was the recipient of the Gary Medal of the American Iron and Steel Institute for his contributions to the steel industry.

Mr. Bent gave generously of his time and talents to the advancement of ordnance design and production for the Army and Navy of the United States.

• **K. C. GARDNER,** chairman of the board of United Engineering and Foundry Company and its chief executive officer, died on April 15, 1955, at Sewickley, Pa. He was a charter member of the Pittsburgh Post of the American Ordnance Association and a member of the advisory board of the Pittsburgh Army Ordnance District.

He first became associated with the company through one of its predecessors, the Lloyd Booth Company in Youngstown, Ohio, in 1899, after his graduation from the University School and the Case School of Applied Science of Cleveland.

Upon the formation of United in 1901, Mr. Gardner was appointed machinery sales engineer. He was elected to the board of directors in 1911, became vice-president in 1928, advanced to general manager of sales in 1929, then to the office of president and general manager in 1943 and to the chairmanship of the board of directors of the company in 1952.

Mr. Gardner was also a director of the Peoples' First National Bank and Trust Company, Woodlings Verona Tool Works, Pittsburgh Testing Laboratory, and other companies and organizations.

• **WILLIAM BAUMBECK,** for many years general superintendent of Rock Island Arsenal, Rock Island, Ill., died on Monday, April 4, 1955. For more than forty years he was a guiding influence in the design and production of field artillery for the United States Army.

A resident of Davenport, Iowa, Mr. Baumbeck was born in Westphalen, Germany. He came to the United States in 1896 and entered the service of the arsenal in 1904 as a machinist. During the First World War he organized and expanded the turret lathe department of the arsenal and undertook the quantity production of artillery.

Following that war he became superintendent of production and took a prominent part in the maintenance of the arsenal shops during the period until World War II. He became general superintendent in 1926.

Throughout his service he designed numerous tools which made possible the development of many machines essential to the mass production of ordnance.

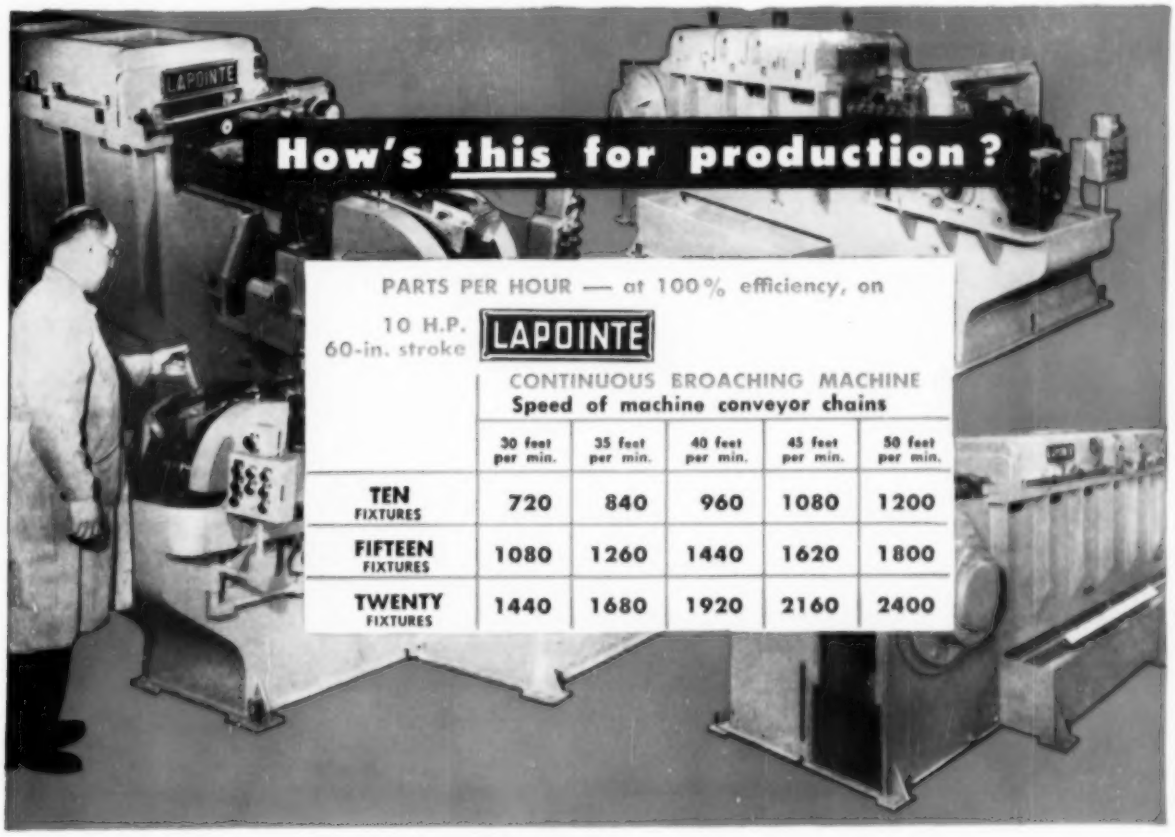
In 1943 Mr. Baumbeck received the Army's highest civilian citation for exceptional service. It was presented to him at Washington by the late Henry L. Stimson, then Secretary of War.

Mr. Baumbeck was known intimately to the officers of the Ordnance Department of the Army, to many of whom he taught the principles of machine design and production techniques. His devotion to Rock Island and to the Army were of such deep and lasting influence that his name for more than four decades was a synonym for the best in American ordnance.

• **WILLIAM A. ROBERTS,** president of the Allis-Chalmers Manufacturing Company and a director of the Milwaukee Post, American Ordnance Association, died at Milwaukee, April 12, 1955. He had served as president of the company since 1951 and had been a member of the Ordnance Association for many years.

A native of Missouri, he joined the Allis-Chalmers organization in 1924, becoming general sales manager for the tractor division and a vice-president of the company in 1944.

In 1952 Mr. Roberts was named the winner of the American Schools and Colleges Association's Horatio Alger Award, his career having paralleled that of the original Horatio Alger. His deep interest in all progress related to the national defense of our country was noteworthy.



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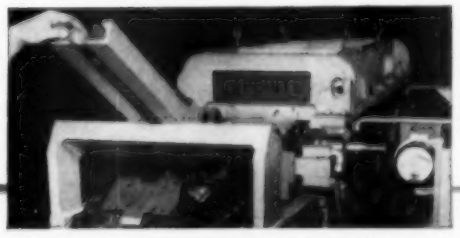

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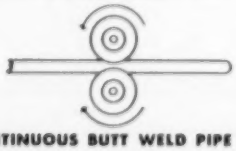

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ORDNANCE R.O.T.C. MEDALISTS

The honor Ordnance cadet in each of the R.O.T.C. units in colleges throughout the country was awarded the American Ordnance Association Scholarship Key for the year 1955 and a year's membership in the Association at recent presentation ceremonies. Awards were made at the following institutions:

University of California.—Cadet Col. Samuel K. Mihara, San Francisco, Calif., is majoring in mechanical engineering and is a member of the Institute of Aero Sciences and the American

H. H. Moorer, Jr. J. F. Mondt S. K. Mihara

Rocket Society. Cadet Mihara hopes to be commissioned in the Regular Army after his graduation in June 1956.

University of Cincinnati.—Cadet Howard L. S. Moy, Sacramento, Calif., is majoring in electrical engineering.

The Citadel.—Cadet Lieut. Col. H. H. Moorer, Jr., Charleston, S. C., winner for the second consecutive year, expects to continue graduate work in chemistry, his major field at the University of Tennessee. He is second vice-president on the board of directors for the American Ordnance Association at The Citadel and is an outstanding cadet in ordnance.

Clemson Agricultural College.—Cadet Capt. Whitten E. Little, Myrtle Beach, S. C., received the A.O.A. award at the regimental review on May 8th which was witnessed by more than 12,000 persons. The presentation was made by Col. George A. Douglass, professor of military science and tactics.

Colorado A. & M. College.—Cadet Jack F. Mondt, Hardin, Colo., is majoring in mechanical engineering and will go to Richland, Wash., to work with General Electric in atomic research.

University of Connecticut.—Cadet Capt. Glen W. Swanson, Long Hill, Conn., is majoring in business administration and is a member of the Society for the advancement of management and the National Military Society of Scabbard and Blade.

Cornell University.—Cadet Lieut. Col. John D. Baldeschwieler, Cranford, N. J., majoring in chemical engineering, stands first in military R.O.T.C. classes from 1952 through 1955. He was chairman for Engineer's Day, 1955.

J. P. Isaacs J. D. Baldeschwieler G. W. Swanson

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Ordnance R.O.T.C. Medalists

R. L. Easley | E. J. Smits | J. E. Lancaster | A. C. Stocker | J. W. York | A. R. Bartolacci

Dartmouth College.—Cadet Jed P. Isaacs, Brooklyn, N. Y., is enrolled in the Amos Tuck School of Graduate Business Administration and is advertising manager of WDBS, the college radio station, and company commander in the R.O.T.C. unit.

Georgia Institute of Technology.—Cadet Maj. John E. Lancaster, Chattanooga, Tenn., is majoring in textile chemistry and has been granted a fellowship to do graduate work at the Institute of Textile Technology at Charlottesville, Va. He is president of the student chapter of the American Association of Textile Chemists and Colorists.

Hofstra College.—Cadet Lieut. Col. Edward J. Smits, Freeport, N. Y., is majoring in political science and has been on the dean's list for two years. He will be commissioned in Ordnance at the completion of the summer camp at Aberdeen Proving Ground.

University of Illinois.—Cadet Ronald Lester Easley, Vermont, Ill., is majoring in engineering physics and was selected as executive officer for the Army R.O.T.C. Brigade for the 1955-1956 school year.

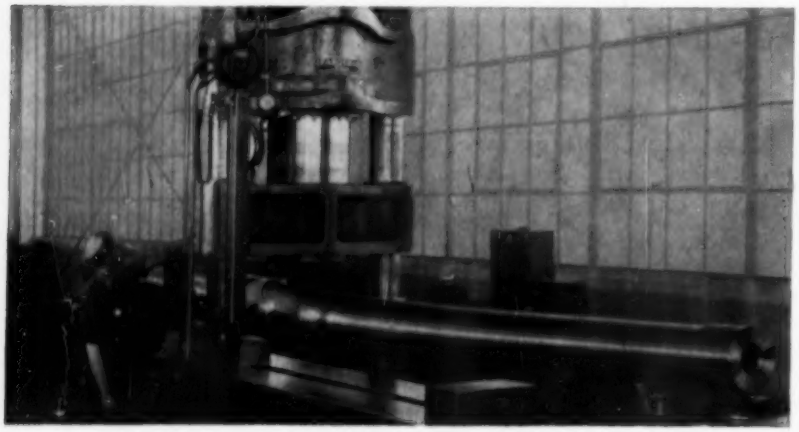
Lafayette College.—Cadet Lieut. Col. August R. Bartolacci, Phillipsburg, N. J., is majoring in industrial engineering. He recently received the Anniversary Student Branch award of the American Society of Mechanical Engineers and also a graduate scholarship to Lehigh University.

Lehigh University.—Cadet Col. Herbert Ross Ford, Jr., Chatham, N. J., is majoring in marketing. He is a member of the student council and in the Service Society received an award when a senior for outstanding service to the school.

University of Maine.—Cadet John William York, Norway, Me., is majoring in mechanical engineering and is a member of the American Society of Mechanical Engineers.

Marshall College.—Cadet Lieut. Col. Roy F. Stein, Ashland, Ky., is majoring in business administration and will go on active duty at Aberdeen Proving Ground in July 1955.

Massachusetts Institute of Technology.—Cadet Lieut. Col. Ashton C. Stocker, Boston, Mass., is majoring in business and administration engineering and will be commissioned as a 2nd lieutenant in the Ordnance Reserve Corps, U. S. Army.



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University of Minnesota.—Cadet Regimental Sgt. Maj. James H. Koplin, Detroit Lakes, Minn., expects to continue graduate work toward a Ph.D. in psychology. His fields of interest include optics and fire control, and he received the Col. Ladd Minute Man Medal when he was a freshman.

University of Nebraska.—Cadet Lieut. Col. Carl G. Mammel, Omaha, Nebr., is a student of the College of Business Administration. He has been commander of the Ordnance Battalion and plans to start his career as an insurance underwriter after graduation from the university.

J. D. Stachiw J. H. Koplin L. E. Enderle

Oklahoma A. & M. College.—Cadet J. D. Stachiw, Stillwater, Okla., is majoring in mechanical engineering. Following graduation he will depart for Pennsylvania State College where he has accepted a research assistantship in automotive engineering.

Purdue University.—Cadet Maj. Gerald L. Liedl, Fergus Falls, Minn., is majoring in metallurgical engineering.

Rutgers University.—Cadet Louis E. Enderle, Collingswood, N. J., is majoring in business administration and is the president of the school's newly organized chapter of the A.O.A. He attended the summer camp at Aberdeen in 1954 and was named the outstanding cadet in his company. He is a member of the Scarlet Rifles drill team.

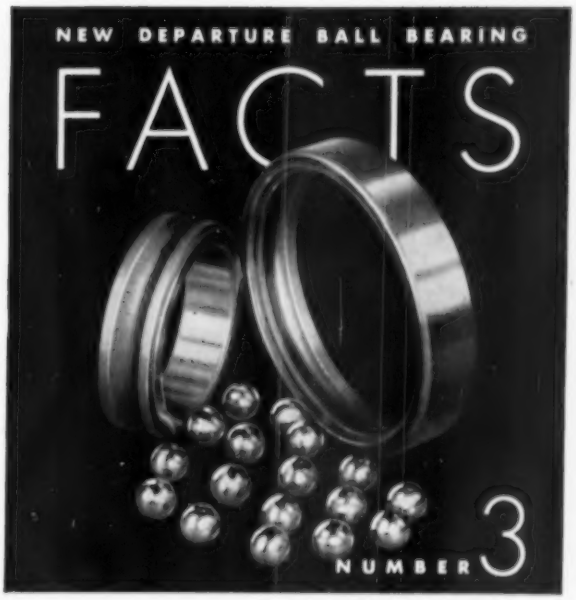
Seattle University.—Cadet Lieut. Col. Richard P. Clayberg, Seattle, Wash., has attained a sufficient position scholastically on the honor roll of the school to merit consideration for a Rhodes Scholarship. He is presently the plans and training officer in the school's Provisional Cadet Regiment.

A. & M. College of Texas.—Cadet Capt. John B. White, III, Jacksonville, Tex., majoring in mechanical engineering, is commanding officer of the Ordnance Company of the R.O.T.C. Unit and a member of the American Society of Mechanical Engineers.

University of Toledo.—Cadet Maj. Roger A. Rose, Toledo, Ohio, is majoring in chemical engineering and is a member of the University Chemical Engineering Society. He will be commissioned upon graduation in June 1956. Cadet Rose attended the Branch General R.O.T.C. Summer Camp at Fort Campbell, Ky., in 1954. As a senior he was appointed to the rank of cadet major and is S-3 of the cadet regiment at the university.

Virginia Polytechnic Institute.—Cadet Capt. Lyman H. Reynolds, Bristol, Va., is majoring in industrial engineering. He is president of the Southwest Virginia Club and is active in the American Institute of Industrial Engineers. Cadet Reynolds stands first academically in the industrial engineering class of 1955, numbering 36 seniors, and 29th in the senior class of 528 members. He has an average grade of 89 in the Ordnance Unit.

J. B. White, III R. A. Rose L. H. Reynolds



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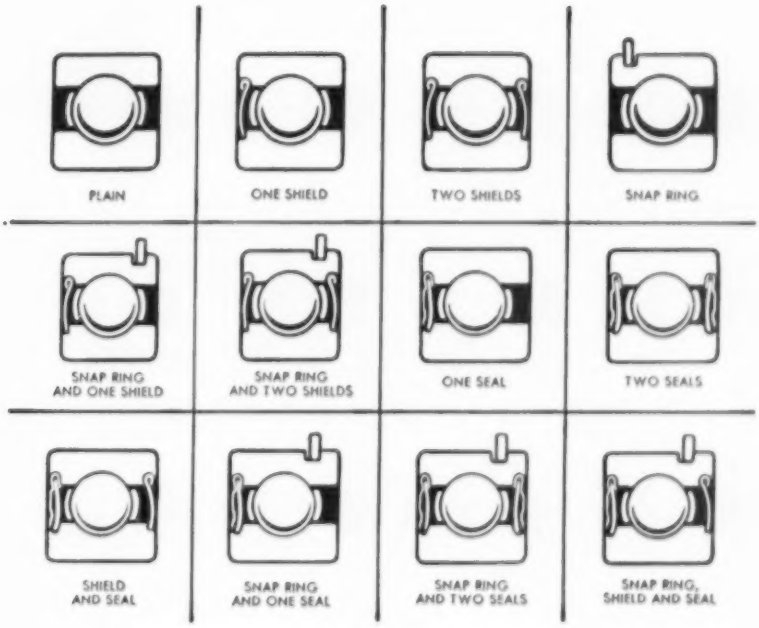

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Grade I	Bonderite 100, 160, 170, 180
Grade II	
Type 2	Parco Cleaners 341, 350, 371
Type 4	Parco Cleaners 250, 260
Type 5	Parco Cleaners 210, 220
Type 6	Parco Cleaners 100, 101, 110
MIL-10578A (Formerly U.S.A. 3-213)	
Type I (Wash-off)	Parco Cleaner 250
Type II (Wipe-off)	Parco Cleaner 260
MIL-C-5541 (Formerly AN-C-170)	Bonderite 700, 710, 720 (chemical film for aluminum and its alloys)
MIL-C-12968 (ORD) (Supersedes in part U.S.A. 57-0-2)	
Type A—(Formerly U.S.A. 57-0-2, Type I, Class A & A1)	Parco Powder, Parco Lubrite 1 & 2
Type B	
Class 1 (Formerly U. S. A. 57-0-2, Type II, Class B)	Parco Compound
Class 2	Parco Compound plus Endurion
MIL-C-16232A (BuORD)	
Type I	Parco Lubrite 1 & 2
Type II	Parco Compound
PA-PD-191	
Grade I	Bonderite 32, 34, 100, 160, 170, 180
Grade II	
Type 2	Parco Cleaners 341, 350, 371
Type 4	Parco Cleaners 250, 260
Type 5	Parco Cleaners 210, 220
Type 6	Parco Cleaners 100, 101, 110
U.S.A. 72-53	Bonderite 32, 34, 100, 160, 170, 180
U.S.A. 57-0-2 [See also MIL-C-12968 (ORD)]	
Type II	
Class A & A1	Parco Lubrite 1 & 2
Class B	Parco Powder—Parco Compound
Class C	Bonderite 100, 160, 170, 180

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Bomb Committee Meets at Globe American Corporation

The Bomb Committee of the Bomb and Artillery Ammunition Division met at the Globe American Corporation, Kokomo, Ind., on April 18-19, 1955. Nick L. Etten, Chamberlain Corporation, Waterloo, Iowa, is the chairman of the Committee; F. Donald Hart, Temco Corporation, Nashville, Tenn., is the deputy chairman; and Brig. Gen. Merle H. Davis, U.S.A. (Ret.), Franklin, Vt., is secretary.

The 1955 meeting of the Bomb Committee featured research and development on bombs and related items. All three services —Air Force, Navy, and Army—were represented as well as industry.

A. P. Chester, president of the Globe American Corporation welcomed the group and asked J. R. Comer and John E. Real

Present at the Bomb Committee meeting were, left to right above: H. E. Rifenbark, Maj. B. E. Wilson, Committee Chairman N. L. Etten, H. S. Beckman, Brig. Gen. M. H. Davis, A. Z. Cohen, Brig. Gen. T. K. Vincent, and J. F. Fox. The Committee met at Globe American Corp., Kokomo, Ind., April 18-19, 1955.

of the Globe American Corporation to continue to handle their end of the arrangements for the meeting. Mr. Etten outlined the agenda, and Lieut. Col. A. P. Wehrle, Army Ordnance Corps, representing the Cincinnati Ordnance District, spoke for the district chief in welcoming the Committee to the district. Brig. Gen. T. K. Vincent, U.S.A. (Ret.), brought greetings from the national A.O.A. headquarters.

Technical papers were presented and discussed as follows: "Operation 'Mopping Up'" was outlined by General Davis, and detailed papers were given by Harry S. Beckman, Office, Chief of Army Ordnance, Washington, D. C.; James F. Fox, Navy Bureau of Ordnance, Washington, D. C.; A. Z. Cohen and David M. Lipnick, Army Chemical Corps Material Command, Baltimore, Md.; H. E. Rifenbark, Wright Air Development Center, U.S.A.F., Dayton, Ohio; D. W. Fletcher, National Tube Division, United States Steel Corporation, Pittsburgh, Pa.; and Neil H. Cargile, representing Allen Products Corporation, Nashville, Tenn.

"Bomb Shapes" was presented by Lieut. M. R. Orlow, U.S.A.F., Wright Air Development Center.

"The Hep Bomb" was presented by S. Altschuler, Chicago Midway Laboratory, Chicago, Ill.

"Gun Firing of Bombs for Terminal Ballistics" was discussed by Frank W. Kasdorf, Naval Proving Ground, Dahlgren, Va.

"Development of the T36 Cluster" was presented by Irving Herman and E. J. Webster, Chamberlain Corporation, Waterloo, Iowa.

"Development of the T27 Cluster" was presented by W. F. Hagman, G. T. Keller, and John Denton, Globe American Corporation; H. L. White, the White Corporation; and Dr. Harold M. DeGroff, Purdue University.

"Plastic Fuel Tanks and Fire Bombs" was presented by Irving Poretz, Headquarters, U.S.A.F., Washington, D. C.

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"Typical Air Force Dispensers" was presented by Dr. Harold Hawkins and Fred Everett, Cook Research Laboratory.

"Ejector Racks" was presented by E. J. Horkey, Pastushin Aviation Corporation, Los Angeles, Calif.

"Bomb Handling Equipment" was presented by W. M. Neff, Wright Air Development Center.

At the conclusion of the technical sessions the Globe American Corporation arranged a tour of its manufacturing plant and also showed the 90-mm. steel cartridge case line which it is maintaining in stand-by under power for Army Ordnance by contract with the Cincinnati Ordnance District.

This was an excellent example of the working of the new plan, known as "Operation Ready," which is a great advance in industrial preparedness.

The equipment for the display of slides, charts, and moving pictures was superior, and R. O. Wagner, Globe American Corporation, who operated these many devices, deserves special commendation for the finest arrangements ever seen.

On Monday evening, April 18th, the hosts invited all attending the meeting to be their dinner guests at the Kokomo Country Club.

The papers presented at this meeting were all classified and will not be published.

Rocket and Jato Committees Meet at Naval Ordnance Lab

The Rocket Committee and the Jato Committee, Guided Missile, Rocket and Jato Division, held a joint classified meeting at the Naval Ordnance Laboratory, White Oak, Md., on April 28, 1955.

Thurman F. Naylor, Koppers Company, Baltimore, Md., is chairman of the Rocket Committee, with David W. Fletcher, National Tube Division, U. S. Steel Corporation, Pittsburgh, Pa., as deputy chairman and F. C. Hutchison, Hesse-Eastern Corporation, Cambridge, Mass, as secretary.

Lyman D. Warner, American District Steam Company, North Tonawanda, N. Y., is chairman of the Jato Committee, with Andrew J. Peterson, Goodyear Aircraft Corporation, Akron, Ohio, and Alexander F. Giacco, Hercules Powder Company, Wilmington, Del., as deputy chairmen. Carl E. Johnson, Scaife Company, Oakmont, Pa., is secretary of the Jato Committee.

Capt. John T. Hayward, U.S.N., commander of the Naval Ordnance Laboratory, welcomed the two Committees and commented on his great personal interest in the field of rockets and jatos.

Dr. Gregory K. Hartmann, technical director of the Naval Ordnance Laboratory, discussed the mission of the establishment and outlined some of the work being carried on in the rocket field.

C. L. Eksergian, chairman of the Guided Missile, Rocket and Jato Division of the American Ordnance Association, discussed the Division activities and their tie-in with the three services and industry. Technical papers were presented and discussed as follows:

"Honest John Free Flight Artillery Rocket," by Casper J. Koeper, chief, Design Branch, Rocket Development Division, Ordnance Missile Laboratories, Redstone Arsenal, Huntsville, Ala.

"Problems of Armament on Jet Aircraft," by Lieut. L. G. Body, U.S.N., staff experimental officer, Naval Ordnance Test Station, Inyokern, Calif.

"The Bureau of Aëronautics Jato 15KS-1000 Mk. 6, Mod. 0," by R. J. Mill, chief, Armament Department, Aerojet-General Corporation, Azusa, Calif.

"Recent Naval Weapons Development," by Comdr. W. C. Han-

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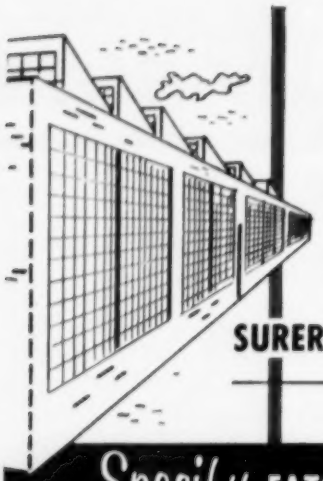

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son, U.S.N., head, Guided Missile Branch, Navy Bureau of Ordnance, Washington, D. C.

At luncheon in the laboratory cafeteria, Brig. Gen. T. K. Vincent, U.S.A. (Ret.), staff consultant for A.O.A. Technical Divisions and Committees, acted as toastmaster. Capt. J. M. P. Wright, U.S.N. (Ret.), staff consultant for A.O.A. Posts and Chapters, introduced Capt. John T. Hayward, U.S.N., commander of the Naval Ordnance Laboratory, who talked informally to the group, relating some personal experiences pertinent to the work of the Committee.

Captain Wright then introduced the guest speaker, Capt. U. S. Brady, Jr., U.S.N., program director for guided missiles, Navy Bureau of Ordnance, Washington, D. C., who spoke informatively and entertainingly on the subject, "A Glance at the Crystal Ball."

After the luncheon, the group was divided into sections and toured the environmental laboratory, plastics laboratory, wind tunnels, and ballistic ranges.

The papers presented will not be published due to their classified nature.

Small Arms and Small Arms Ammunition Division Meets at Springfield Armory, Mass.

The Small Arms and Small Arms Ammunition Division met at the Springfield Armory, Springfield, Mass., on May 5, 1955. Fred F. Hickey, Savage Arms Corporation, Utica, N. Y., is chairman of the Division; Maxwell R. Warden, Remington Arms Company, Bridgeport, Conn., is deputy chairman; and Col. Wallace L. Clay, U.S.A. (Ret.), Remington Arms Company, Bridgeport, Conn., is secretary.

About 140 members and guests from industry and the military services attended the technical sessions.

After a welcome by the armory commander, Col. D. G. Ludlam, the technical meeting got under way. All of the following papers were confidential and none of them will be published:

"General Remarks on the Light Rifle Program," by Lieut. Col. R. E. Rayle, chief, research and development, Springfield Armory; "Current Status of the T48 (FN) Rifle," by C. Packard, Springfield Armory; "Current Status of the T44 Rifle," by S. Fish, Springfield Armory; "Discussion of User Tests," by Lieut. Col. W. T. Gordon, Infantry, U.S.A., headquarters, CONARC, Fort Monroe, Va.; "Current Status of Hand Arms," by E. Cousineau, Springfield Armory.

"General-Purpose Machine Gun Development," by P. Marshall, Springfield Armory; "Spotting Rifle," by E. M. Harvey, Springfield Armory; "Tank Machine Gun," by H. F. Hawthorne, Springfield Armory.

"Ammunition for Ground Weapons," by Dr. A. N. Benson, Frankford Arsenal, Philadelphia, Pa.; "Revolver Aircraft Weapons," by O. H. von Lossnitzer, Springfield Armory; "Multibarrel Aircraft Weapons," by J. R. Eves, Springfield Armory; "Ammunition for Aircraft Weapons," by E. W. Read, Frankford Arsenal.

The entire group was taken to the Page Boulevard Test Building where Captain Schreck, Ordnance Corps, U.S.A., showed the facilities for testing and demonstrated weapon firing of light rifles, general-purpose machine guns, tank machine guns, spotting rifles, and 20-mm. and 30-mm. aircraft weapons. Light rifles were available for firing by the A.O.A. members.

A dinner session was held at the Sheraton-Kimball Hotel in Springfield with Fred F. Hickey as toastmaster who called on the following for brief remarks:

Brig. Gen. T. K. Vincent, A.O.A staff consultant for Technical Divisions and Committees; Col. Frederick H. Payne, a char-

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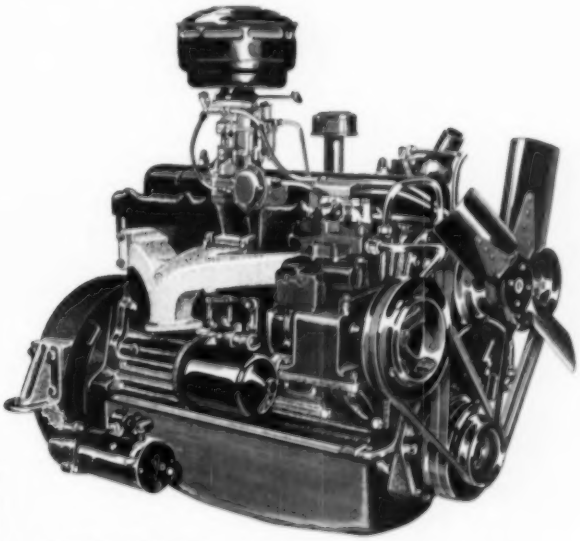

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ter national director of the Association; Col. Maurice L. Driscoll, Army Ordnance Corps, deputy chief, Springfield Ordnance District; and Brig. Gen. Theodore A. Weyher, commanding general, Ordnance Weapons Command, Rock Island Arsenal, Ill.

Mr. Hickey then introduced the principal speaker, Brig. Gen. John B. Medaris, Assistant Chief of Army Ordnance and chief of the Industrial Division, Office of the Chief of Ordnance, Washington, D. C.

General Medaris spoke informally in closed session to the assembled industry and military guests on the Ordnance-Industry relationships with particular reference to small-arms activities.

The meetings of this Division are held annually. The Committees of the Division do not meet as often as some of the other Committees due to the continuation of Integration Committee activities in this field. The annual meeting of the Division fulfills the need for interchange of information with industry at large, and this meeting was particularly fine.

It was announced very regretfully that Colonel Clay, who has been secretary of this Division since its establishment, was retiring from the Remington Arms Company in July and was also retiring as secretary of the Division.

The remarkable record established by Colonel Clay in his administration of the Small Arms and Small Arms Ammunition Division will be difficult to equal and impossible to surpass.

His devotion to the Ordnance-Industry cause, his willingness to undertake all tasks regardless of the work involved, and his conscientious attention to detail are a few of the characteristics of this fine officer.

Chairman Hickey announced that Col. John W. Crowe, Army Ordnance Corps (Ret.), formerly the commanding officer of Springfield Armory and now associated with the Savage Arms Company, will succeed Colonel Clay as secretary of the Division.

BOMB AND ARTILLERY AMMUNITION DIVISION HOLDS MEETING AT SHREVEPORT, LA.

The Bomb and Artillery Ammunition Division, with Robert L. Telford, Mason & Hanger-Silas Mason Company, Shreveport, La., chairman, presiding, held a 2-day meeting in Shreveport, La., on May 9-10, 1955. Walter N. Howley, Lansdowne Steel & Iron Company, Morton, Pa., is the deputy chairman of the Division, and Richard T. Buffington, Mason & Hanger-Silas Mason Company, is secretary.

On the first day of the meeting the members could visit either Eglin Air Force Base, Fla., to witness an aerial firepower demonstration or Barksdale Air Force Base and the Louisiana Ordnance Plant in Shreveport.

Both visits were well planned, and about 150 members left the hotel at 6 a.m. for Barksdale Air Force Base where they boarded Air Force airplanes for transportation to Eglin.

This group reported a fine day, thrilling and awe-inspiring demonstrations, and a healthy respect for the Air Force.

About fifty members chose to leave later in the morning, breakfasting with Brig. Gen. Maurice A. Preston, commander, Barksdale Air Force Base, at the Officers' Open Mess. The group then toured the base, examining first-hand many of the airplanes that had been only names to them before.

This group then visited the Louisiana Ordnance Plant, a government-owned, contractor-operated ammunition establishment. Remington Rand has the operational contract. James A. Ward, plant manager, and Hubert E. Evans, assistant manager, were hosts to the group at a very fine luncheon at the plant cafeteria. There followed a complete tour of the 155-mm. shell plant where billets are received at one end and emerge at the other end as finished 155-mm. shells ready for the explosive to be loaded into them.

All these visits were well planned, and the Air Force hosts at Eglin A.F.B. and at Barksdale A.F.B. went all-out to make the visits instructive and interesting. Their hospitality, as well as that of the hosts at the Louisiana Ordnance Plant, was superb, and several hundred industry and service representatives became boosters for our Air Force-Army-Navy-Industry Ordnance Team.

The dinner session at the Shreveport Country Club was attended by about 200 members of the Division and of the Louisiana Post. Chairman Bob Telford presided at the dinner meeting and introduced Brig. Gen. T. K. Vincent, U.S.A. (Ret.), A.O.A. staff consultant for Technical Divisions and Committees, as the toastmaster.

The principal address was given by Maj. Gen. Archie J. Old, Jr., director of operations, Strategic Air Command, Offutt Air Force Base, Omaha, Nebr. His informal talk, describing the scope, activities, and responsibilities of the Strategic Air Command, was enthusiastically received.

The technical session opened at 8 a.m. on May 10th in the Lake Room of the Captain Shreve Hotel with Walter Howley presiding. All the Committees were

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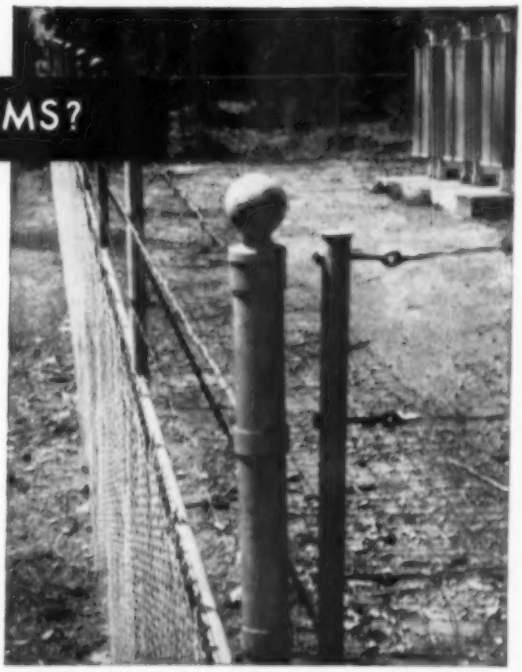

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represented, and reports of their activities were presented informally or by means of prepared papers.

Brig. Gen. Robert G. Butler, Jr., commanding general, Ordnance Ammunition Command, Joliet, Ill., discussed the Ordnance command organization concept and the problems encountered in integrating the industrial and field-service functions as well as the coördination of the product areas.

Col. Paul S. Bechtel, director, Plans and Programs Ammunition Center, United States Air Force Research Command, Eglin Air Force Base, Fla., presented a thought-provoking and informative paper on "Air Armament and Weapons Systems Development."

Harold S. van Buren, Procter & Gamble Company, cochairman of the Loading Committee, presented a paper on "Uniform Packaging of Ammunition Components Supplied to Loading Plants."

Brig. Gen Merle H. Davis, secretary of the Bomb Committee, reported on the very successful meeting of that Committee at the Globe American Corporation, Kokomo, Ind., and made some forecasts of expected bomb problems.

Larry Schiller, Norris-Thermador Corporation, a member of the Cartridge Case Committee, presented a paper on the "Heat Treatment of Artillery Cartridge Cases."

Thomas C. Smith, Daystrom Electric Corporation, deputy chairman of the Fuze Committee, presented a paper prepared by Chairman James E. Burke on "Past and Prospective Operations of the Fuze Committee," adding pertinent comments relative to Committee activities and the trend toward electric and electronic fuzes.

Mr. Howley, as chairman of the Shell Committee, discussed informally the operating procedure of that Committee.

Dr. Gerard W. Mulder, Cleveland Container Company, a member of the Container Committee, reported on its activities, functions, and future forecasts.

Russell G. Cone, Mason & Hanger-Silas Mason Company, read a paper prepared by Brig. Gen. Joel Holmes, U.S.A. (Ret.), on "Single-pour Controlled-cooling Method of Loading Ammunition."

The meeting of this Division was most successful. The tours arranged for the first day of the session set the pattern for the technical session that followed. All papers were well prepared and of interest to all. It is planned to publish them in brochure form for distribution by national A.O.A. headquarters.

Congratulations are due Bob Telford, Lieut. Col. J. T. Holley, liaison officer with the Division from the Air Force, Russell Cone, Jim Ward, the members of the Louisiana Post, and the many others who had a hand in arranging the meeting.

POWDER METALLURGY GROUP MEETS AT RED BANK, N. J.

The Powder Metallurgy Committee, Advisory Technical and Research Group, met at the Molly Pitcher Hotel, Red Bank, N. J., under the chairmanship of Andrew J. Langhammer, Amplex Division, Chrysler Corporation, Detroit, Mich. About forty-eight members attended this unclassified meeting.

Chairman Langhammer welcomed the group and called on Brig. Gen. T. K. Vincent, A.O.A. Staff Consultant for Technical Divisions and Committees; Brig. Gen. Joseph M. Colby, commanding general, Frankford Arsenal, Philadelphia, Pa., representing Army Ordnance; Capt. G. B. H. Stallings, U.S.N., Assistant Chief for Material, representing the Navy Bureau of Ordnance; and Charles B. Hartley, Wright Air Development Center, Dayton, Ohio, representing the Air Force Matériel Command, for brief remarks.

The discussions were informal, no papers being presented.

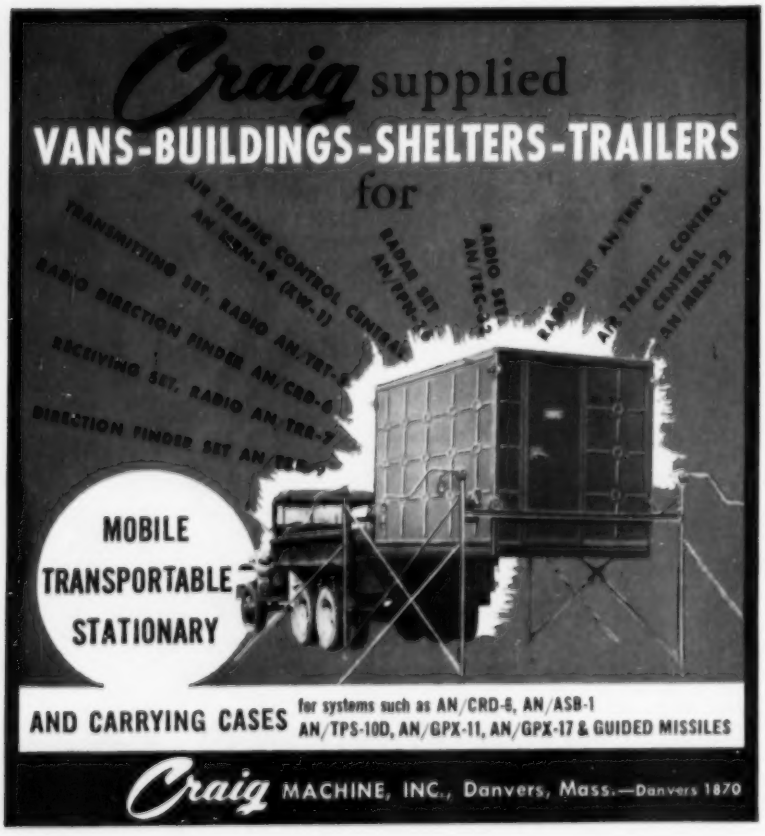
Raw materials were discussed by H. E. Hall, Metal Disintegrating Company, Elizabeth, N. J., and by E. du Pont in John P. Ruth's absence.

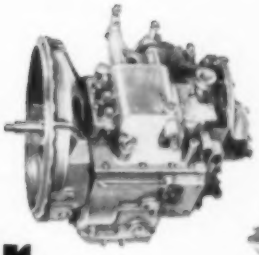
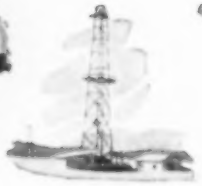
Technical discussions were carried on in informal fashion by R. P. Koehring, General Motors Corporation, Detroit, Mich.; Col. John Dale, Charles Hardy Company, New York, N. Y.; William Reich, General Electric Company, Detroit, Mich.; Sam Tour, Sam Tour Company, New York, N. Y.; John Redmond, Kennametal Corporation, Pittsburgh, Pa.; K. H. Kuhlen, Chrysler Corporation, Detroit, Mich.

Also by Dr. Gregory Comstock, Stevens Institute of Technology, Hoboken, N. J.; L. H. Bailey, F. J. Stokes Machine Company, Philadelphia, Pa.; H. O. Johnson, Bound Brook Oil-less Bearing Company, Bound Brook, N. J.; D. C. Bradley, New Jersey Zinc Company, New York, N. Y.; F. Sylvester, General Ceramics and Steatite Company, Keasby, N. J.

Also by C. D. Owens, Bell Telephone Laboratories, New York, N. Y.; Carl Johnson, Presmet Company, Worcester, Mass.; G. F. Finley, Hoegannes Sponge Iron Company, New York, N. Y.; and E. T. Rose, American Metal Company, Ltd., New York, N. Y.

After lunch at the hotel the technical session continued with a general discus-



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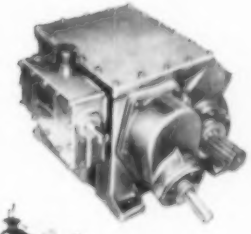

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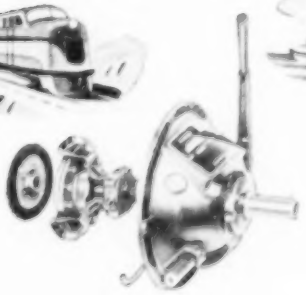
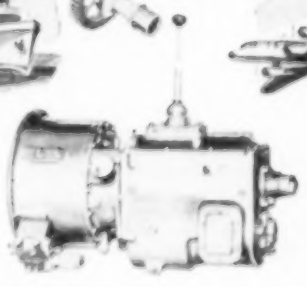

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sion. At 2:30 p.m., the meeting adjourned to Red Gables, the home of Colonel Dale, for an afternoon devoted, according to the program, to "research, contests, explorations, sailing" followed at 5 p.m. by a barbeque.

Instrumentation Committee Meets at Patrick A.F.B.

The Proving Ground Instrumentation Committee of the Fire Control Instrument Division held a classified meeting at the Air Force Missile Test Center, Patrick Air Force Base, Cocoa, Fla., on April 14-15, 1955. Hugh C. Carroll, General Electric Company, Schenectady, N. Y., is the chairman of this Committee. William A. Wildhack, National Bureau of Standards, Washington, D. C., was the chairman of the Program Committee.

William A. Wildhack

The sessions were held in the base theater at Patrick Air Force Base. Maj. Gen. Donald N. Yates, U.S.A.F., commander of the Air Force Missile Test Center, welcomed the group and explained that the Center was one of the ten research, development, and testing establishments of the Air Research and Development Command.

Its mission is to establish, operate, and maintain the Florida Missile Test Range and its supporting facilities for the purpose of conducting tests and collecting test data on guided missiles, drones, and allied equipment for the Air Force, and for the Army and Navy when directed.

It also supports the Air Force contractors and other governmental testing agencies, evaluates tests performed by the Air Force or Air Force contractors, and conducts and supports all testing and operational training.

Brig. Gen. T. K. Vincent, U.S.A. (Ret.), A.O.A. staff consultant for Technical Divisions and Committees, responded and brought greetings from national headquarters of the Association.

The morning session on April 14th was under the chairmanship of Mr. Wildhack, with Maj. P. G. Galentine, Air Research and Development Command, Baltimore, Md., as cochairman.

The following technical papers were presented and discussed:

"Problems in Trajectory Measurement at the Air Force Missile Test Center," by K. S. Rizk, Air Force Missile Test Center, Patrick Air Force Base, Cocoa, Fla.

"Trends in Optical Instrumentation for Trajectory and Altitude Measurements," by Alexis N. Dember, Naval Ordnance Test Station, Inyokern, Calif.

"Relative Position Determinations during Air-to-Air Fire Control Tests," by Maj. E. B. Blair, U.S.A.F., Air Force Armament Center, Eglin Air Force Base, Fla.

"Precision Requirements in Position-Time Measurements," by J. E. Barker, U. S. Naval Proving Ground, Dahlgren, Va.

"Project 'Hit-More'," by W. J. Gabriel, Consolidated Vultee Aircraft Corporation, Fort Worth, Tex.

The afternoon session on April 14th was under the chairmanship of Mr. Carroll, with B. W. Pike, Naval Ordnance Test Station, as cochairman. Technical papers were presented and discussed as follows:

"Special Communications Problems in Connection with Range Instrumentation," by H. W. Nylund, Bell Telephone Laboratories, New York, N. Y.

"High Precision Tracking Radar," by Nathaniel I. Korman, Radio Corporation of America, New York, N. Y.

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"Chain Radar Acquisition Equipment for Optical Instrumentation at White Sands Proving Ground," by Carl Duckett, White Sands Proving Ground, Las Cruces, N. Mex.

"Problems in Obtaining Meteorological Data," by Abraham Arnold, Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

"Determination at Altitude of Cross-wind Ballistic Data of Projectiles," by John K. Sterrett, Air Force Armament Center, Eglin A.F.B., Fla.

"Recent Developments in Miniature Radar Beacons for Guided-Missile Instrumentation," by P. T. Maresca, Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

On the evening of April 14th, a dinner session was held at the Trade Winds Club Hotel, Indialantic, Melbourne, Fla., with about 300 members and guest present. General Vincent acted as toastmaster. The guest speaker was Brig. Gen. Victor M. Haugen, U.S.A.F., director of laboratories, Wright Air Development Center, Dayton, Ohio, who spoke on the subject, "The Equipment Industry's Relationship to the U.S.A.F. and Weapons Systems Contractors."

His talk was informal and was illustrated with charts showing the selection of contractual methods, the procedure for major new items secured by subcontract to the weapon systems contractor, the procedure for items secured by the associate contract method, and the procedure for testing for contract compliance both in associate contracts and major new item subcontracts.

The morning session on April 15th was under the chairmanship of Brig. Gen. E. P. Mechling, U.S.A.F., commander of the Air Force Armament Center, Eglin A.F.B., Fla., with J. C. Talley, Naval Proving Ground, Dahlgren, Va., as co-chairman. The following technical papers were presented and discussed:

"Problems in Automatic Film Reading," by L. G. De Bey, Ballistic Research Laboratories, Aberdeen Proving Ground, Md.

"A Centralized Data Processing System," by Jerome J. Dover, Air Force Flight Test Center, Edwards A.F.B., Calif.

"Use of Electronic Digital Computer in Support of Armament Testing," by E. D. Allmon, Air Force Armament Center, Eglin A.F.B., Fla.

"Servo-controlled Mount for Optical or Infrared Instrumentation," by H. J. Merrill, Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

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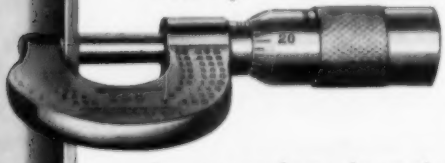

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Association Affairs

Divisions and Committees

"The Application of Statistical Methods to the Design and Analysis of Experiments," by David S. Stoller, Rand Corporation, Santa Monica, Calif.

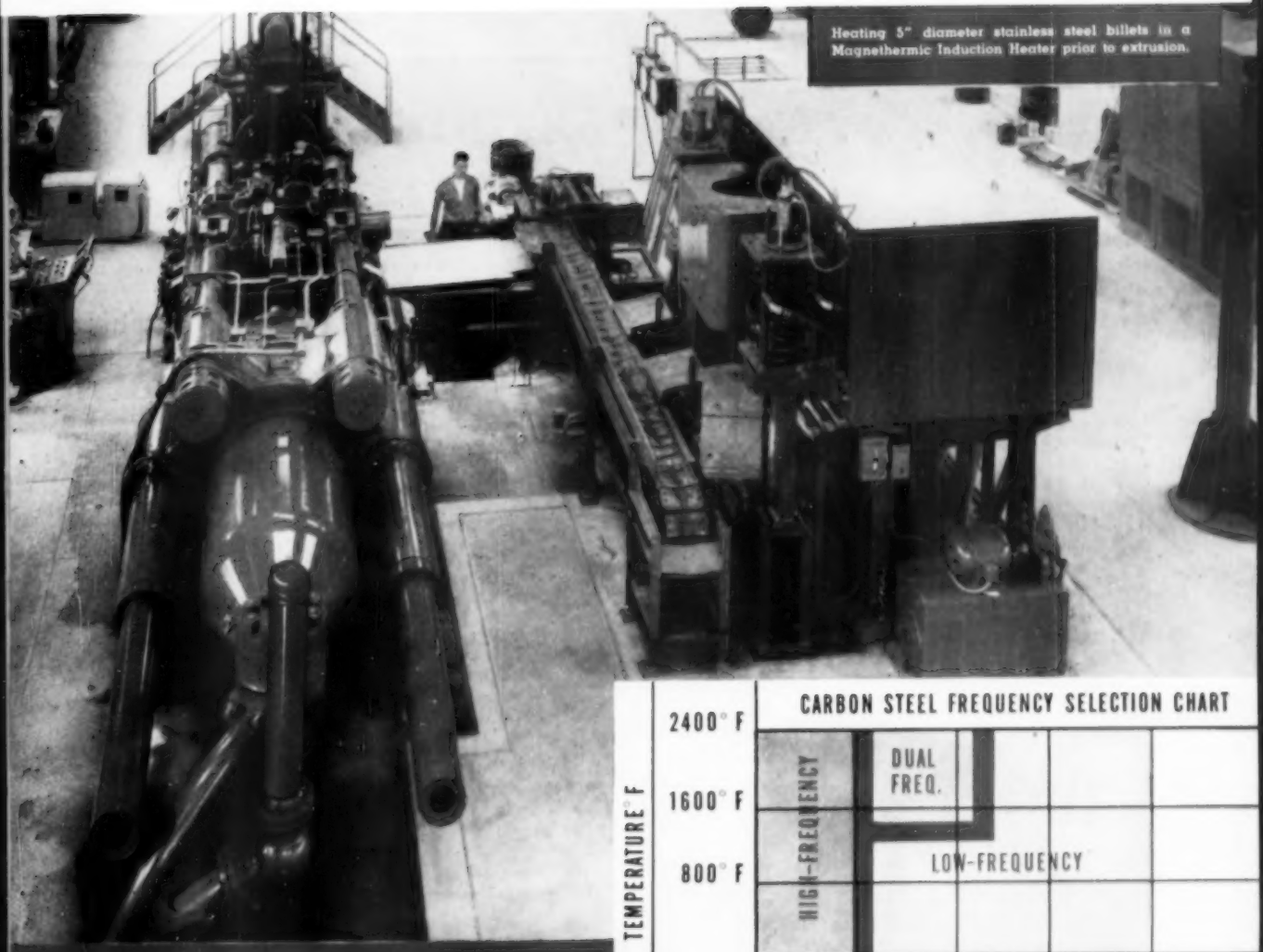
Col. H. J. Sands, U.S.A.F., chief of staff, Air Force Missile Test Center, briefed the group on the operations of the center and the physical layout of the test facilities at Cape Canaveral Auxiliary Air Force Base and the Florida Missile Test Range. The Cape Canaveral facilities were visited in the afternoon, and an excellent briefing and demonstration of the test facilities operation were given.

DR. W. G. BAKER HEADS NEWLY REORGANIZED ELECTRONICS COMMITTEE

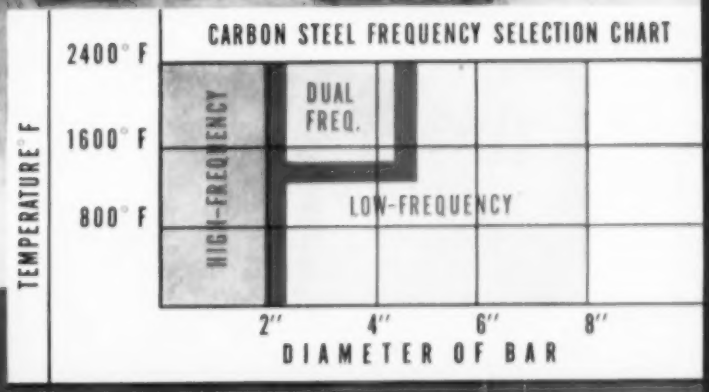
The Electronics Committee of the Fire Control Instrument Division has been rejuvenated under the chairmanship of Dr. Walter R. G. Baker, General Electric Company, Syracuse, N. Y. The following officers of the Committee are assisting Dr. Baker: Dr. J. W. McRae, president of Sandia Corporation, Albuquerque, N. Mex., deputy chairman; Brig. Gen. T. C. Rives, U.S.A.F. (Ret.), General Electric Company, Syracuse, N. Y., secretary; and G. W. Cain, Frankford Arsenal, Philadelphia, Pa., adviser to the chairman.

There are three Subcommittees under the Electronics Committee: Electronic Components Subcommittee, Ground and Shipborne Subcommittee, Airborne Electronics Subcommittee.

Members of the Committee are: Lieut. Col. J. S. Lambert and Co. Harold C. Teubner, Air Research and Development Command, Baltimore, Md.; Dr. A. C. Hall, Bendix Aviation Corporation, Detroit, Mich.; J. T. Evers, Lester Lang, S. E. Petrillo, and A. Rogers, Signal Corps Engineering Laboratories, Fort Monmouth, N. J.; C. T. Foss, R. Y. Miner, Dr. P. H. Savet and J. P. Toner, American Bosch Arma Corporation, Garden City, N. Y.; Henry McKenney, George Schroeder, Victor Seliger, and Edward Wagner, Ford Instrument Company, Long Island City, N. Y.; William P. McNally, Murray Simpson, and John A. Vaughan, W. L. Maxson Corporation, New York, N. Y.; Harry Davis, Griffiss Air Force Base, Rome, N. Y.; Walter J. Moe and Carl E. Swanson, Remington Rand Inc., St. Paul, Minn.; Roy Graeter, General Electric Company, Syracuse, N. Y.; George S. Peratino, Office, Chief of Army Ordnance, Washington, D. C.; James V. Burke, Lieut. Col. Roger H. Terzian, Lieut. Col. Fred C. Schmidt, Jr., and Maj. Lewis W. Hieatt, Wright-Patterson Air Force Base, Dayton, Ohio; and O. H. Winn, General Electric Company, Utica, N. Y.



Heating 5" diameter stainless steel billets in a Magnethermic Induction Heater prior to extrusion.



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Greater Uses of Aluminum.—New applications of aluminum are appearing constantly, and the widening uses indicate that aluminum now is not only generally accepted for its own qualities, and not merely as an "alternate metal" for special cases, but that its production facilities have now reached a stage where the metal is commercially available in any of the varied forms regularly marketed in other metals.

Domestic production of primary aluminum for 1954 was reported at 1,460,000 short tons, or 16 per cent above that of 1953, and the output this year may be close to double that of the peak war year 1943.

It will be recalled that as war orders were curtailed in 1944 aluminum production fell off rapidly to 496,000 tons in 1945. The last of the Government-owned plants were closed in October 1945, and there were many who believed that our metal capacity had been greatly overbuilt for any peacetime needs.

Production of aluminum in 1938, the year before the outbreak of World War II, had been only 143,440 tons, and even in 1945 designers outside the transportation-equipment industries were hardly alert to the use possibilities of the metal.

Following the installation of facilities for large tapered sheet and plate at Davenport, Iowa, and an extra-heavy extrusion press at Lafayette, Ind., *Aluminum Company of America* recently started into production two giant forging presses at Cleveland under an Air Force program. Now to be installed at Davenport is a $10 million plate stretcher capable of exerting a 2-way pull of 8,000 tons, which will produce heat-treated aluminum plate in thicknesses up to 6 inches, widths to 144 inches, and lengths to 60 feet.

The first products from the 35,000- and 50,000-ton hydraulic presses at Cleveland were a wing spar for a jet interceptor and another for a new jet tanker. Other parts to be made for the Air Force are landing-gear bulkheads, tapered I-beams for wings, reënforced skin panels, and wing-beam carry-through fittings. Some parts that could be made on smaller presses are more accurate and need less machining when made on the big machines.

The press designs were based on the German experience that high constant pressure is more desirable than a hammer blow for forging aluminum and magnesium, and the large die-pressed forgings permit one-piece construction of airframe parts, resulting in lighter military aircraft.

It has been estimated that there is an average of about 20 pounds of aluminum going into the 1955 automobile. There is an average of 43 pounds of copper per automobile because of the large amount used in electrical equipment, but on a volume basis aluminum is now ahead of copper.

Another growing civilian use of aluminum is for strong, light die castings. About 42 per cent of aluminum casting ingots are going into die castings in 1955, and this year about 138,000 tons of aluminum will be used for die castings.

There is no dropping off in zinc die castings, which are estimated at 280,000 tons for 1955, but on a volume-of-parts basis aluminum die castings are now far ahead of zinc.

A new 100-foot oil-well telescoping derrick capable of drilling to 5,000 feet with 3½-inch pipe is made entirely of aluminum to keep within highway weight limits. The derrick, built by the *Franks Manufacturing Corporation*, Tulsa, Okla., working with *Reynolds Metals Company*, Louisville, Ky., has square tubular aluminum legs and bracings and gives a saving of 40 per cent in weight compared with former steel derricks.

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Materials Progress

Radiographic Inspection.—The new Isoscope of the *Babcock & Wilcox Company*, New York, for radiographic inspection of steel up to 7 inches thick, is made with 1,008 curies of cobalt 60, stacked in small disks in a steel-encased lead sphere. The Isoscope requires only about one-third the exposure time of a one-million volt X-ray machine, costs less, and is easier to shield.

Xenon Lamps.—Xenon lamps for special military applications are being produced by *Westinghouse Electric Corporation*, East Pittsburgh, Pa. They give an excellent white light (sunlight plus north-sky light), and the color does not change with the voltage and thus requires no voltage regulators. A xenon lamp of 800 watts delivers 2,000 lumens on a projector screen, while a 1,000-watt incandescent lamp delivers only 500 lumens. The xenon lamp relights each half cycle, so that shutterless projectors are possible for motion picture work. Xenon is one of the rare gases.

Flash Lamps.—This same corporation has also redesigned its camera flash lamp to give more light in smaller space without any essential change in materials. The miniature lamp is made cylindrical instead of tapered, thus giving more volume for foil. It measures only 1¼ inches long and ¼-inch in diameter, giving 5,200 lumen-seconds compared with 4,200 lumen-seconds for any previous lamp of the type. A packet of 12 bulbs is now small enough to slip into a blouse pocket.

Enamel for Bluing.—Replacing the old method of bluing rifle barrels with a fused salt bath, *Daisy Manufacturing Company*, Plymouth, Mich., is now using a blue resin enamel, thus saving space and time in its annual production of 2,000,000 air rifles and toy guns.

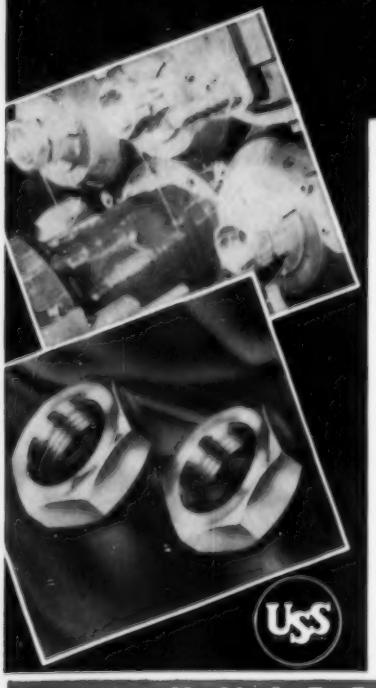
The enamel, a product of the *Egyptian Lacquer Company*, Newark, N. J., has an epoxy resin base (Epon resin, of *Shell Chemical Corporation*, New York, N. Y.). It is applied by an electrostatic spray unit metered to a constant rate, giving a dry film thickness of 0.003-inch with one coat. The cost of finishing the barrels is only 20 per cent of the cost of the former bluing method.

Silicon Rectifiers.—A new line of silicon rectifiers in sizes from 100 to 500 milliamps with voltages from 50 to 500 capable of operating at 99 per cent efficiency at temperatures to 200 degrees Centigrade, or twice the temperature possible for selenium rectifiers, is being made by *Bogue Electric Manufacturing Company*, Paterson, N. J. Compactness is the big feature, the unit being only one-eighth cubic inch in size and weighing only 0.1-ounce.

Miniature Rectifiers.—Germanium rectifiers are now being regularly manufactured by the *General Electric Company*, Schenectady, N. Y., for conversion of A.C. to D.C. power current. They are extremely small compared with ordinary converter units, a germanium rectifier rated at 125 volts and 800 amperes being only about the size of a 10-cent piece. The germanium unit is highly efficient, with only very small reverse current. Germanium does not withstand high temperatures and requires water cooling, which, though prohibitive for electronic equipment, is not a disadvantage for power-line rectifiers.

Selenium Rectifiers.—Practically all makers continue to produce selenium rectifiers, and selenium has remained in tight supply. But now *Westinghouse* has a new method of coating rectifier plates that conserves selenium and improves the plate. The selenium is coated by an evaporation process which gives better control with thinner coatings and eliminates contamination. It also improves the electrical characteristics, the forward resistance of the cell being 30 per cent less, and the reverse resistance 100 per cent greater.

How the use of NATIONAL Seamless EXTRUDED Stainless Tubing cuts nut manufacturing costs



USING NATIONAL SEAMLESS EXTRUDED USS Stainless (type 303) Tubing, the Tri-Clover Division of Ladish Corporation is now turning out hexagonal nuts in less time and at lower cost than they could using solid bar stock. The savings in material cost alone amounts to 11.77 cents per piece.

All machining on the nuts, except threading and O.D. finishing, is done in one operation on a 6-spindle, 3½ inch Conomatic automatic machine. A saving of five seconds in the time cycle was made by using the extruded hexagonal stock versus bar stock. The use of hex tubing has eliminated the cost and upkeep of boring tools—and, because tubing is considerably lighter than bar stock, it can be handled faster and with less difficulty.

NATIONAL EXTRUDED Tubing offers you high strength, uniformity, and dependability that only *seamless* tubing can give. For a better precision part, involving fewer operations and fewer machine hours, investigate NATIONAL Seamless EXTRUDED Tubing—made by the world's largest manufacturer of tubular steel products. Feel free to call us if you'd like help in applying NATIONAL Seamless to your product.

National Tube employs a hot-extrusion process known as "Sejournet" in which white-hot billets of steel are squeezed into tubing of various shapes by a 2,500-ton hydraulic press and ram — a manufacturing method that insures absolute uniformity of wall strength.

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
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NATIONAL Seamless EXTRUDED TUBING

UNITED STATES STEEL

POWERFUL MIDGET

RAYTHEON Silicon Power Rectifier

Typical of Raytheon's new approach to old problems is this revolutionary Silicon Power Rectifier. It is superior to ordinary rectifiers six ways:

- Extremely small, rugged, reliable
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- Higher current rating (15 amperes)
- Negligible voltage drop
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Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

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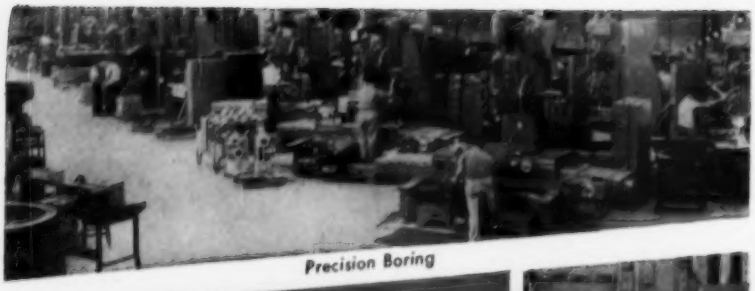

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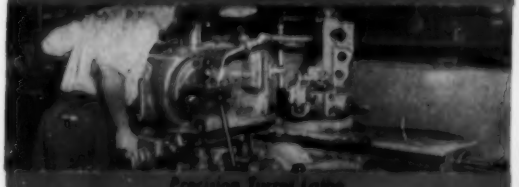

Precision Turret Lathe

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Daystrom Instrument

Archbald, Penna.

Division of Daystrom, Inc.

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Materials Progress

Smaller Motors.—Improved materials have resulted in greatly reduced size and weight of electric motors since the war, a matter of importance for many types of civilian products in addition to great advantages for military equipment. More powerful magnet alloys, better synthetic insulation for slots, and synthetic resin coatings that permit reduction in wire diameters in windings have been the chief factors. This year the *National Electrical Manufacturers Association* will complete its rerating standards for motors, and a 30-horsepower motor may now be no larger than an older 15-horsepower motor.

Concentrated Foods.—Weight- and space-saving efforts are not confined to mechanical and electrical equipment. The Navy, especially, is requesting more concentration in foodstuffs to save space. Test cruises recently made by two submarines using concentrated foods saved 25 per cent in space and thus gained 21 days' provision endurance. The *Western Utilization Research Branch* of the Department of Agriculture, Albany, Calif., has developed a tomato powder that stores well for long periods and can be reconstituted quickly into tomato juice by merely adding water. The powder used for beverage juice is made by a 2-stage process of vacuum drying the liquid and pulp fractions separately.

A lower-cost method is to spray-dry the concentrated paste. The powder made by this process does not reconstitute as easily, but is satisfactory for soups and is cheaper. Incidentally, the Navy uses about 12,000 tons of canned tomatoes annually.

Manganese Production.—Manganese has figured on all lists of strategic military materials for the past two decades, but there are good prospects that the metal will no longer be in a strategic or critical class when new methods are perfected for utilizing economically the vast resources of low-grade manganese ores available in this country.

The Government for some time has been paying premium prices for manganese dioxide produced by beneficiation of domestic ores, but informed technicians believe that the answer to utilization of our low-grade ores will not be found in mechanical beneficiation but rather in chemical processing.

Pure manganese carbonate powder of 325 mesh that can be converted easily to manganese dioxide nodules for use in steel and in other applications will be produced at the rate of 50 tons daily as soon as the new plant of the *Manganese Chemical Corporation*, at Riverton, Minn., is in full production.

The plant uses low-grade ore of 10 to

MODERN SCHEDULES DEMAND—POWER...

FLUID POWER

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Dual-Vane Hydraulic Pumps, 3 to 120 gpm; Fluid Motors, 7 to 140 hp; 2000 psi operation. Piston-Type Pumps for 5000 psi.

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WATERTOWN DIVISION

Watertown, N. Y.

Railroad air brake valves for freight and passenger equipment, STRATOPOWER Hydraulic Pumps for Aircraft, to 3000 psi.

KINNEY MANUFACTURING DIVISION

Boston, Mass.

Rotating Plunger and Heliquad Liquid Handling Pumps, to 3000 gpm. Vacuum Pumps, 0.2 micron, evacuate 1800 cfm.

AURORA PUMP DIVISION

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Liquid Handling Pumps, Centrifugals, 4000 gpm, 500 ft. heads. Turbine-Types, 7000 gpm. Condensate Return Units.

Vehicles that haul 75 ton loads... Shovels that handle 16 yards and more at a single bite... these are but two of the many juggernauts that move mountains or mole hills... that give industry *higher production at lower cost*. And the key to velvet-smooth control of all this harnessed energy is Fluid Power!

Mine, Construction, Marine, Oil Field, Farm and Materials Handling Equipment attain ever-increasing productivity through the rugged dependability of Fluid Power. Machine Tools, Presses, Paper Machinery, Petro-chemical and other processing equipment achieve greater automation plus micrometric precision through Fluid Power.

There are three divisions of The New York Air Brake Company which concentrate on the development of advanced design hydraulic equipment for this Fluid Power. Thus, from a single source, industry may have the ideal component for the specific function. . . . Gear, Dual-Vane and Piston Pumps, embracing a full range of capacities and pressures to 5000 psi, and Motors, Control Valves and Cylinders to develop complete hydraulic circuits.

In addition to Fluid Power, industry finds the answers to its liquid handling problems in Aurora and Kinney Pumps. "Any material that can be pushed through a pipe" . . . from gasoline and alcohol to tars, sludges, slurries and other heavy semi-solids ...and the less dramatic tasks of sump, deep well, boiler feed, and household needs are all dependably handled by these famous pumps.

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6-10 years experience in missile or aircraft electronic package design. Familiarity with vibration and other environmental problems essential.

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23 OTHER ENGINEERING POSITIONS!

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Materials Progress

15 per cent manganese. The ore is roasted to MnO, ground to 35 mesh, slurried with ammonia and carbon dioxide to form manganese ammonium carbonate which is then heated with steam to drive off the ammonia and precipitate to manganese carbonate. A number of other processes are under development for the chemical reduction of low-grade manganese ores.

Nickel Powder.—Chemistry, rather than time-honored metallurgy, is also the basis of production of high-purity nickel powder at the new *Sheritt-Gordon* metallurgical research plant at Fort Saskatchewan, Alberta, Canada. The powder contains 99.87 per cent nickel and 0.1 per cent cobalt, while ordinary electrolyt nickel contains 0.1 to 0.8 per cent cobalt and 0.02 per cent each of iron and copper. The plant is treating 2,000 tons of ore daily, and the powder already has been used effectively for making porous sintered battery plates.

Ceramic Coatings.—Jet-engine tail cones and some other parts of jets are now generally protected by high-temperature enamel coatings, according to *Barrows Porcelain Enamel Company*, Cincinnati, Ohio. The ceramic coatings adhere well to iron, cold-rolled steel, and stainless steels but not to nonferrous metals.

The coatings are usually 0.005- to 0.030-inch thick, but the high-temperature coatings on stainless steel are generally only 0.001- to 0.0015-inch. The ceramic will resist severe thermal shock and also mechanical impact up to the yield point of the base metal.

Insulating Paint.—A new insulating roof paint being produced by the *Monroe Company*, Cleveland, Ohio, is an ingenious formulation of asphalt, silicone resin, and drying oils, with asbestos fiber filler and aluminum flake pigment. The paint can be brushed or sprayed on. It adheres well and acts as a good preservative for wood, while the aluminum, which flakes to the surface, reflects the rays of the sun and gives good heat insulation. The paint is called Asbestolite.

High-strength Porous Metal.—Porous metals are not normally noted for high strength, but the Poroloy now being produced by *Poroloy Equipment, Inc.*, Pacoima, Calif., which can be made in almost any commercial metal, has tensile strengths up to as high as 85,000 pounds per square inch when made with stainless steel.

As a filter it is offered as a material that will withstand continuous vibration and sudden pressure surges in high-temperature filtering and is capable of being cleaned easily by backwashing. It also appears promising as a material for

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Save Up to 80% on Fastening Costs with the REMINGTON STUD DRIVER

"Cuts my conduit anchoring cost by an average of 74%"—writes one electrician about his Remington Stud Driver, and it's a typical report. With a speed of up to 5 studs per minute, this powder-actuated tool is bringing new economy to the job . . . new opportunities for electrical contractors.

Many maintenance men are finding they can speed up installations, get more jobs done with the Remington Stud Driver. Others tell us that the tool's light weight—6 lbs.—makes overhead work a lot easier. All are agreed that you can't beat the Stud Driver for setting studs in concrete and steel.

What's your fastening job? Whether you're fastening eye bolts for stringing wires or conduit clips to concrete, you'll save money with the Remington Stud Driver. For further information on how this amazing tool can help solve your fastening problems, mail the coupon below.

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Materials Progress

boundary-layer control to reduce drag on high-speed fighter planes and for porous-wall cooling in jet engines.

Poroloy is made up of continuous strands of fine wire bonded at the cross-over joints by sintering. The size, spacing, and path of the pores is controlled by accurate mechanical positioning of the wires, and the pore configurations may be straight through, as in an ordinary wire-cloth screen, or they may be on an angle or in a zig-zag path. The material comes in sheets of various thicknesses (0.015- to 0.125-inch) in sizes up to 24 by 56 inches and in seamless tubing up to 18 inches in diameter.

New Insulation.—A sheet insulation that has a higher dielectric strength than mica and will withstand temperatures to 500 degrees Fahrenheit, which is higher than that found in most of the resin-bonded mica substitutes, is the new Fiberfilm developed by the *American Machine & Foundry Company*, New York, N. Y. It consists of a fluorocarbon resin (Teflon, of *Du Pont*) with a filler of fine glass fibers.

At present it cannot be had in sheets as thin as split mica, the thinnest now offered regularly being 0.60-inch, but thinner sheets are made for insulation in capacitors, motor slots, coils, and for high-temperature wire and cables. A porous grade is available for high-temperature, chemical-resistant filtering. The film has a dielectric strength of 1,750 volts per mil and dielectric constant of 2.1.

Radiation Shielding.—Combining the radiation-shielding qualities of lead metal with the easy molding ability of a synthetic plastic resin, the *Telectro Industries Corporation*, Long Island City, N. Y., is offering a new material known as Leadcast. The material consists of up to 95 per cent lead powder combined with 5 or more per cent of a synthetic resin binder.

It can be molded to intricate shapes, inserts can be molded in, and the molded product has greater structural rigidity than cast lead and has a smooth-finished surface. It is being recommended for instrument-housing shielding, containers for radioactive materials, protective wall panels, and interlocking bricks for temporary movable shielding.

Plastic Piping.—A new line of Duravin rigid unplasticized polyvinyl chloride piping being marketed by *Wilmington Plastics, Inc.*, Wilmington, Del., comes in sizes from ¼ to 4 inches in standard and heavy weight. The standard pipe is recommended for safe pressure from 300 to 100 pounds per square inch and the heavy weight for pressures up to 400 pounds per square inch for the small size and 175 pounds for the large size.

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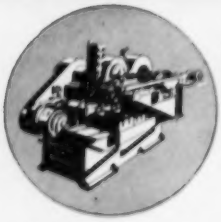
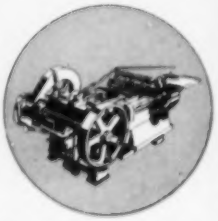
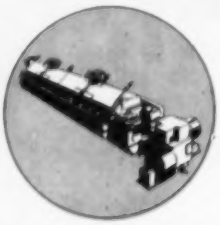


COLD PROCESS BOLT & NUT MACHINERY —Headers (all types) • Rivet Machinery Trimmers • Thread Rolling Machines Slotters • Nut Formers and Tappers, etc.

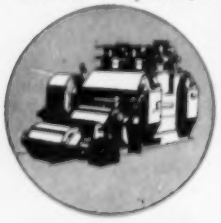


POWER PRESSES — Crank, Cam and Toggle; also Rack and Pinion Presses • Eyelet Machines • Multiple Plunger Presses • Horizontal and Hydraulic Presses, etc.

MILL MACHINERY — Rolling Mills: Strip, Rod, Tube, Wire Flattening, (For Ferrous and Non Ferrous Metals) • Also Slitters • Straighteners • Cut-off Saws • Coilers • Winders, etc.

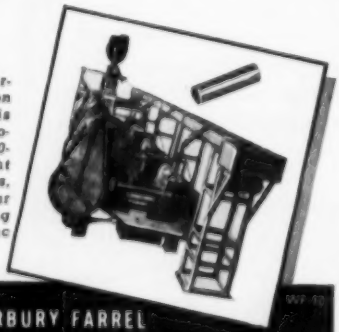


WIRE MILL EQUIPMENT — Continuous Wire Drawing Machines (Upright Cone and Tandem) • Wire Flattening Mills • Chain Draw Benches • Pointers • Swagers • Bull Blocks • String-up Machines • Spoolers, etc.



SPECIAL MACHINERY — Sendzimir Mills • Small Arm Ammunition Machines • Thread Rolling Machines For Shells • Collapsible Tube Machines • Coining Mills, etc.

HERE'S A SAMPLE of Waterbury-Farrel mass production equipment in action. This complete WF automatic production unit combines a 40-ton double-acting, upright blanking and cupping press, a conveyor feed and four 7-station horizontal drawing presses to draw 340 zinc shells per minute.



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NEW DEVELOPMENTS

PRESS PROGRAM INAUGURATED

Air Force Secretary Harold E. Talbott on May 5th put huge 35,000- and 50,000-ton hydraulic forging presses into production at Aluminum Company of America's Cleveland works. The $40 million installation became the first complete plant of the Air Force's $279 million heavy-press program to get into operation.

Ranking among the world's largest machine tools, the forging presses tower nearly five stories above floor level and extend another three stories below ground. Weighing more than 6,000 tons each, the presses dominate all other equipment in an aluminum-sheathed plant which contains about 12 acres of floor space under roof. The 35,000-ton press, built by United Engineering and Foundry Company of Pittsburgh, and the 50,000-ton press, constructed by Mesta Machine Company of Pittsburgh, are capable of making larger and more precise forgings than ever before possible.

Heavy presses will make one-piece aircraft parts.

Heavy precision forgings mean stronger, lighter, and less expensive components for all types of modern military aircraft. Their size will permit one-piece construction of airframe parts which formerly required several pieces.

NEW ANTARCTIC EXPEDITION

The Navy has announced that Task Force 43, which leaves the United States in November 1955 to establish bases in Antarctica, will consist of 5 ships, 14 aircraft, 142 officers, and 1,251 sailors. Veteran polar explorer Rear Adm. Richard E. Byrd was called out of retirement to advise and direct the operation, named "Expedition Deep Freeze."

Ships in the force, all from the Atlantic Fleet, will be the icebreakers GLACIER and EDISTO, the cargo ships ARNEB and WYANDOT, and the oiler NESPELEN.

A composite air squadron will consist of two R4D's, two R5D's, three HO4S-2's (helicopters), four US-1's (DeHavilland Otters), two P2V's (ski-equipped), and a UF-1 (triphibian). A battalion of Navy Seabees will construct bases and airstrips.

(Continued on p. 112)

Call AC!

Not many people *can* build equipment that will let you hit an unseen target in flight. As a matter of fact there are very few who are experienced in this highly complex field. But, AC stands high on the list.

The U.S. Army's Skysweeper is radar-directed and controlled by an amazing T-38 "electronic brain" built by AC. It not only detects and tracks intruders, it fires at them with devastating effect.

The deadly accuracy of the Skysweeper is one more step toward pinpoint fire-control methods . . . just one of many steps taken by AC.

If you have a problem in the field of fire control, call AC today!

AC now has several openings for qualified engineers in the electronics field. For detailed information, write to—

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AC SPARK PLUG DIVISION, GENERAL MOTORS CORPORATION
FLINT, MICHIGAN • MILWAUKEE, WISCONSIN

Write for illustrated booklet "AC . . . Engineering for the Future"

New Developments

The main base, from which the expedition will operate, will be located in the Little America area, the site of Admiral Byrd's earlier expeditions to Antarctica. One base will be constructed at 80 degrees south latitude and 120 degrees west longitude and another base will be built at the South Pole.

Ultimate aim of the three-year-long expedition will be the establishment of bases from which American scientific observers can work during the 1957-1958 geophysical year in which the United States and thirty-eight other nations are taking part.

INTERCONTINENTAL MISSILES

Negotiations are under way for a 5,000-mile missile test range extending from Florida, across the South Atlantic, to Ascension Island. The United States expects to be able to fire missiles the length of the course, although they will carry test instruments instead of warheads. It is reported that the United States is working on two types of intercontinental missiles: a supersonic ballistic missile traveling at 12,500 feet a second and a slower-flying, turbojet-powered missile of greater accuracy which is steered by stellar navigation.

REFINING OF TITANIUM

Scientists at the Westinghouse Research Laboratories are purifying titanium and other hard-to-get metals by imprisoning the molten metal inside a cage of its own making. The process, called cage zone refining, uses a unique method to melt a bar of metal while the metal acts as its own crucible, thus preventing contamination by any containing vessel. Object of the process is to prepare superpure metals.

Zone refining in process.

The success of zone refining depends upon the fact that most impurities in metals have a preference for either the liquid or solid state of the metal. Iron, a common impurity in titanium, has a preference for the liquid state of titanium. When a bar of impure titanium is melted progressively from end to end, the iron concentrates in the liquid titanium and follows the molten zone to the end of the bar. This end is then cut off and discarded, leaving the rest of the titanium bar more pure. Each time the process is repeated, more impurities are removed.

HIGH-SPEED TRAINER

The Navy has its first "sea-duty" jet trainer that can exceed 600 miles an hour, yet land at only 97 miles an hour—slower than any other jet. This tandem jet is called the T2V-1. The new aircraft, which is now in production at Lockheed Aircraft Corporation, can operate aboard carriers or on land. It is capable of performing all the maneuvers of a standard Navy fighter.

Among the jet trainer's new features is a "boundary layer control" system. Compressed air from the jet engine is channeled into the wing and squirted through tiny holes directed at the flaps and ailerons.

This new revolutionary system causes the normal airflow to hug the control surfaces and gives the airplane greater

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It will pay you to remember that for the really tough jobs, where ordinary electrical connectors just won't do, be sure to specify the W-Type Connector. Our sales Department will gladly furnish complete specifications and details on request.

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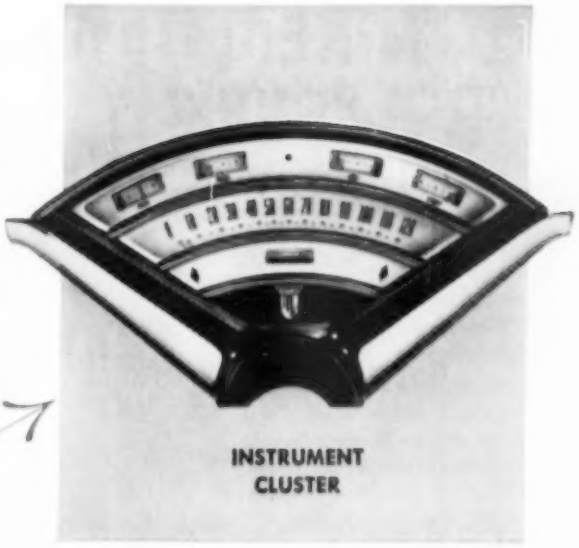

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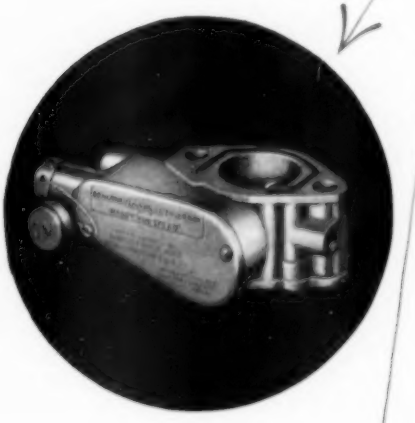

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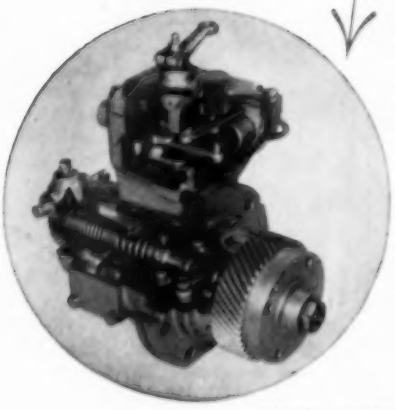

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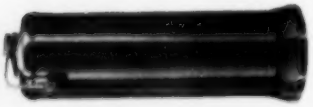
Under subcontract to the Douglas Aircraft Company, which is associated with the Western Electric Company, prime contractor on NIKE, Aerojet-General developed the sustainer rocket motor for NIKE and is producing them for Douglas in large quantities.

The largest industrial organization devoted exclusively to the development and production of rocket powerplants, Aerojet-General is supplying new, bigger and better rocket power for the Nation's defense program.



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lift as well as improved antistall performance.

Other new features include a raised rear seat for fuller vision, movable slats on the wing's leading edge for better low-speed stability, and an arresting hook for carrier landings.

DRONES TEST A-BLAST

Three unmanned QF-80 jet drones from the Air Proving Ground Command recently were exposed to close-in effects of a major atomic blast at the Nevada Test Site. These were F-80 jet fighter-bombers, fitted with robot command guidance systems by Sperry Gyroscope Company as QF-80 pilotless aircraft, for precision flight missions too hazardous to risk human lives.

Ground radar control station.

The three drone jets made electronically controlled take-offs from Indian Springs Air Force Base. Three separate formations were flown, consisting of one drone, two DT-33 director aircraft, and two chase planes, a TF-86 Saberjet and a Navy TF3D escort. The director aircraft is used to control the drones during take-off and flight to and from the orbit area. Each 2-place DT-33 carries a remote-control pilot, who controls the drone, and a pilot to fly the director airplane. Only one director controls the drone, with the other in stand-by.

When the formations reach the orbit area, three ground radars take over control so the unmanned jets are properly spaced before arriving at assigned air positions. Surviving drone aircraft are picked up by airborne directors after emerging from the blast area, and returned to Indian Springs. Upon destruction of a drone, special data-collecting equipment is jettisoned by radio command from its director. Helicopters spot and recover the equipment.

ATOMIC STERILIZATION

The deadly radiation from radioactive substances, already serving mankind in industry, agriculture, and medicine, may be put to other beneficial uses according to investigations conducted by the Corps of Engineers' Research and Development Laboratories, Fort Belvoir, Va., in con-

Bundy solves refrigeration problem with unique tubing strainer design

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Take advantage of this unbeatable Bundy combination: expert, free engineering service plus genuine Bundyweld Tubing, the only tubing double-walled yet stronger; has high thermal conductivity, high bursting strength; takes easily to any fabricating operation. It is the safety standard of the refrigeration industry, *and is used in 95% of today's cars, in an average of 20 applications each.*

Let Bundy help you with that tubing design problem. Call, write, or wire us today:

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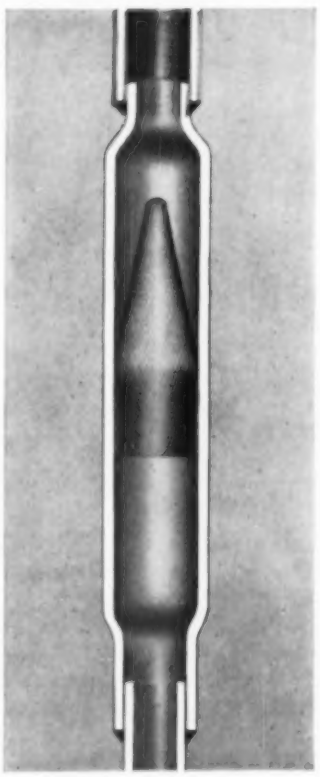
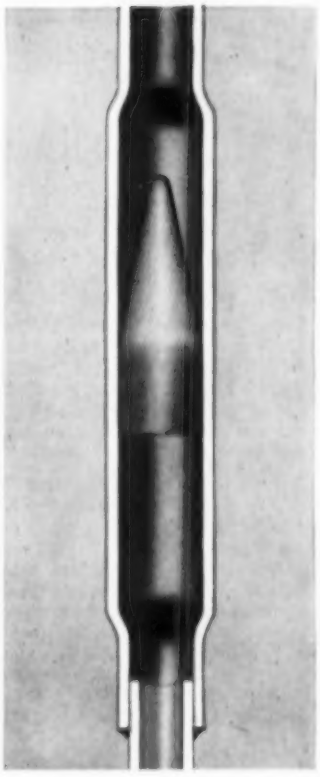


Problem: Because refrigeration systems can be quickly ruined by dirt particles which lodge in capillary tubes, most systems use a separate strainer assembly, as shown above. The two extra solder joints used to install the strainer assembly give rise to an even greater problem—leakage. Expensive hand assembly methods also frequently introduce dirt into the system.



Solution: New Bundy design actually makes strainer an integral part of condenser coil. The coil end is expanded to receive the strainer or filter and then swaged down to capillary size. This ingenious design eliminated one solder joint with its consequent risk of leakage or dirt inclusions; resulted in a cost savings of 50% to the customer.

Bundyweld starts as a single strip of copper-coated steel. Then it's
. . . continuously rolled twice around laterally into a tube of uniform thickness, and passed
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Consider the LeTourneau machines shown here. In each case a team of *big electric wheels* does the instant bidding of *little electric switches* . . . a single operator in the cab of any one of these giants moves a simple control and the machine instantly responds.

Each of the big wheels drives, brakes, and can be steered — for each is a LeTourneau Electric Wheel, a new type of power package consisting of a LeTourneau Electric Motor and Gear Reduction within the rim of the wheel. These wheels float on huge, extra-wide base tires, which provide ground contact area up to 4 feet wide at each wheel for greater traction and flotation than ever before obtainable, making operation possible in deep mud, powdery snow, or loose beach sand.

All functional operations of this new LeTourneau equipment are powered by LeTourneau Electric Gearmotors, and controlled by the machine's single operator with simple electric controls.

This principle of electric power and control is a great new development which has increased mobility for the military and increased production speeds for industry. It is a principle which LeTourneau can put to work for you immediately. May we be of help? Phone, wire or write today.

LeTOURNEAU SNO-BUGGY. Built for exploration of polar areas, including dry, powdery snow. Has huge dual tires on each electric wheel for maximum flotation and traction.

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After six months of research, sanitary engineers have demonstrated that waterborne sewage can be sterilized by gamma radiation without activating or leaving residual radiation in the treated liquids. The waste products from atomic power plants offer one possible source of the required radioactive materials. The possibility exists that these waste products can be used to sterilize water, sewage, and other liquids. Work is continuing to exploit other possible benefits.

AEROBEE-HI ROCKET

A new model of the Aerobee Rocket designed to obtain information on the atmosphere at altitudes up to 135 miles was launched at Holloman Air Development Center recently. Called the "Aerobee-Hi" rocket, it carried an extra-heavy load of instruments on its first flight and attained an altitude of about 123 miles. The launching was the first in a series which will carry through 1956. The rocket is expected to obtain data on solar radiation, sky brightness, and other important natural phenomena encountered at altitudes well above one hundred miles. The rocket was manufactured by the Aero-Jet General Corporation of Azusa, Calif., and was powered by a 4,000-pound-thrust motor.

BOUNDARY LAYER CONTROL

The Air Research and Development Command recently disclosed details of two practical systems of boundary-layer control which will reduce aircraft take-off and landing speeds by one-third and length of runways required by one-half. The systems were developed by ARDC's Wright Air Development Center and tested on F-86F and XC-123D aircraft.

The boundary layer is the name applied to the thin layer of air found next to the surface of aircraft wings in flight. As the wings move through the air, this thin layer drags along the wing surface and causes the air stream to separate from the wings at certain points, particularly at the wing flaps or at the sharp leading edges of thin wings. Since the lifting power of a wing is dependent on a continuous, uninterrupted flow of the air stream over its surface, the separation of the stream caused by the dragging boundary layer considerably reduces lift.

In the first of the two new systems, a suction device was used at the leading edge of an F-86F test aircraft to remove the thin layer of dragging air. The standard leading-edge skin of the F-86F was replaced with a porous, sintered stainless-steel sheet, and a single modified turbo-supercharger was installed in a housing beneath the fuselage to provide the force

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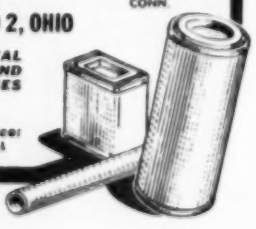
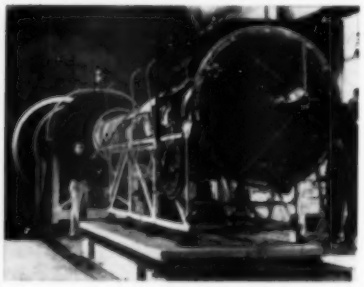


needed to suck the boundary layer into the pores of the sintered sheet. Detailed flight tests made by the NACA Ames Aëronautical Laboratory showed that minimum flying speeds could be reduced by twenty-three per cent.

The second boundary layer control system disclosed was designed for a wing-flap combination, and a C-123 transport airplane (later designated as the XC-123D) was selected as the test vehicle. In this system, both suction and blowing are used to remove or nullify the undesirable effect of the boundary layer.

JET ENGINES TESTED

Operations are under way in the newly built jet engine test cell at Ryan Aëronautical Company, San Diego, Calif., where some of the Nation's most powerful turbojets are being tested. The test



Jet engine on thrust stand.

cell is designed to handle engines with static thrust outputs up to 35,000 pounds.

Most important single measurement in the evaluation of the performance of these turbojets is the measurement of thrust output. To accomplish this in the test cell, Baldwin SR-4 load cells have been installed in the engine test bed which is supported by these cells whose capacity has been selected to accommodate the particular engine being tested and to obtain the most accurate readings possible.

Thrust is read in the control room on a 5-range precision indicator with a switching unit to select the proper load cell. Over-all accuracy of the system is approximately plus or minus one-fourth of one per cent of full-scale load capacity.

FLYING PLATFORM

The Navy has developed a real version of the legendary flying carpet. It's a circular, wingless platform that the pilot, standing upright, steers by leaning in the direction he wants to go. This strange flying machine uses a new principle of lift and propulsion called the "ducted fan," in which two propellers rotating in opposite directions are set horizontally below the platform.

Air is sucked through holes in the platform resulting in a downward thrust that supplies the vertical lift.

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Defense Production is a normal and continuous part of our operation, and we take pride in the many accomplishments we have made. HECO's teamwork and SKILL have resulted in quicker build-ups, lower costs and improved quality in the manufacture of rockets, shells and fuses and their many component parts.

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ARMAMENT ELECTRONICS

Dr. W. S. Carlson

Vacuum tubes, transistors, and other electronic components in fire-control systems, computers, and research devices today are vital elements of much Ordnance equipment. With this issue ORDNANCE *is inaugurating a new department on this subject by Dr. Carlson of Frankford Arsenal to keep its readers up to date on the latest developments in this most important phase of modern armament.*—THE EDITORS.

Dynamic Tester.—Development of a tester to measure dynamic performance of antiaircraft fire-control systems has been initiated by Army Ordnance under contract with Melpar, Inc. Dynamic testing required in connection with engineering evaluation of a weapon system usually entails a series of simulated engagements of target aircraft. System outputs are recorded for comparison with corresponding quantities derived from target flight path data.

A well-instrumented range staffed to operate and maintain optical and electronic position-finding equipment is a prerequisite for testing by field simulation, and auxiliary facilities must be provided for reduction of data and computation of fire-control error.

For budgetary reasons only a few range installations are adequately equipped for testing fire-control systems, and in order to utilize these installations most advantageously operations are necessarily planned well in advance. Testing required in the course of a development program therefore presents difficult scheduling and coordination problems.

Unless remedial action can be taken promptly, component failure or other malfunctions of the equipment under study result in costly interruptions of the test program.

Nor can field simulation be considered entirely satisfactory from an engineering point of view. Target courses are only approximately repeatable. Proving ground terrain may restrict the choice of flight path.

In the dynamic tester being developed, the problem (present-position information and corresponding computed values of the prediction function) are stored in digital form on magnetic tapes. In the interest of simplifying storage and analogue converter circuits, incremental coding has been adopted.

Because the problem and answer data are represented only as the successive first differences of the absolute magnitudes, pulse drop-out will introduce error. With absolute coding lost pulses produce only transient effects. Experiments with pulse sequences recorded on conventional acetate tape have shown that the requisite reliability can be attained.

From a storage tape, increments of data are fed to a counter at the input of a problem channel. Other elements of the channel comprise a high-performance instrument servo.

A code wheel on which two rings of alternately transparent and opaque radial sectors have been printed is carried on the output shaft. As the shaft turns, phototubes on one side of the wheel are intermittently exposed to a light source on the opposite side.

Pulses generated by the phototubes are fed back to the counter. The difference between pulse counts from storage and code-wheel feedback provides an error signal at the counter. This signal in turn is used to modulate a carrier which, after amplification, drives the servo motor.

A secondary loop, containing a tachometer and appropriate filtering circuits, is included for stabilization. Each ring on the code wheel is divided into 400 segments. A half-segment offset between the two rings provides for sensing direction of rotation. A third ring, opaque except for a single slit, and phototube is used for zero reference. The code wheel operates at 160-speed scale factor which represents 40 angular mils per turn.

Appropriate reduction is provided for driving transducer elements such as synchros. In the interest of simplicity and economy, identical components are used in problem output and answer input channels. Referred to a one-speed reference shaft, static probable error of the tester is estimated at slightly over 0.05-mil per channel. Transducer error, *e.g.*, output synchro, and granularity of stored data are the largest sources of static error.

Tests on an experimental model of the digital to analogue conversion servo show that servo lag is less than 0.1-mil at outputs up to 1,600 mils a second referred to a one-speed shaft. A peak transient error of about 0.6-mil was observed in response to a 40-mils-a-second ramp input.

Although the basic outputs and inputs of the tester are shaft positions, a variety of electromechanical transducers can be accommodated. In a typical application,

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Within Continental's range, from two to 1,100 horsepower, it would be hard to name a type of engine-driven product—vehicle, aircraft, boat, or industrial machine—of which one or more of the leading makes do not rely today on Continental power. As might be assumed from the current trend toward greater specialization, the list of such applications is longer than ever before. The field of Red Seal usefulness has broadened to the point where—as this list suggests—there is almost no end to the industrial uses of dependable Continental power.

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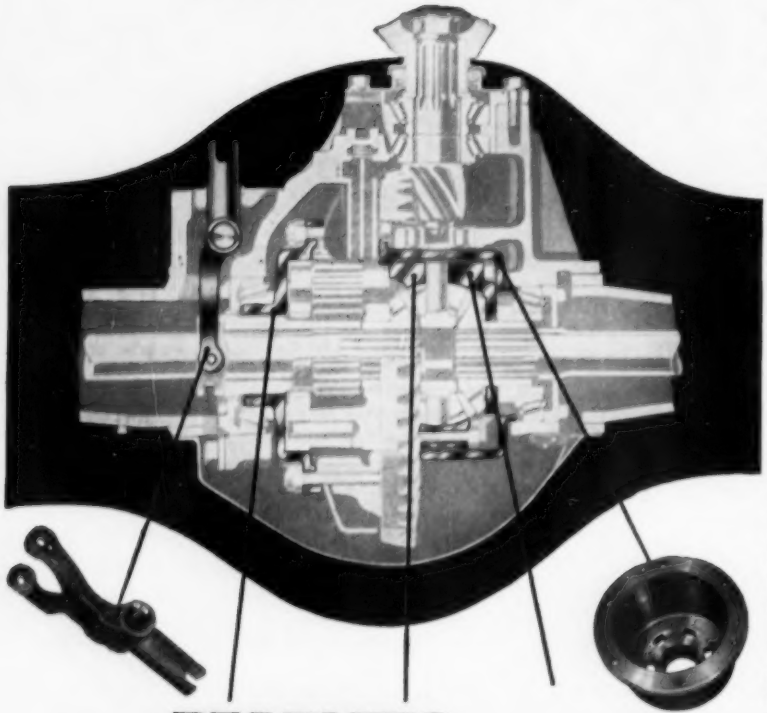

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The 2-speed truck axle is a *must* under varying load and road conditions because it provides a tailor-made ratio for every condition. But it takes a severe beating under heavy duty conditions encountered in logging, mining, farming, etc.

That's why Eaton Manufacturing Company, leading producer of 2-speed axles, specifies pearlitic malleable — from National — for several vital parts. For Eaton knows that pearlitic malleable has high ultimate strength . . . resists wear under heavy loads at high speeds . . . possesses excellent non-seizing properties. In addition, pearlitic malleable can be given a smooth finish . . . can be either liquid or air quenched. And perhaps *most important of all, pearlitic malleable machinability index ranges from 80 to 90* (B1112 steel = 100).

Look your product over critically. Pearlitic malleable castings—from National—can replace costlier fabrication methods . . . can offer opportunities of reduction in weight, machining and assembly time. AA-1197

Photos: Courtesy Eaton Manufacturing Company

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such as testing an artillery power-control system, a synchro transmitter would be geared to the problem output shaft and a control transformer coupled to the answer input. In this instance only electrical connections need be made with the equipment under test.

Realistic testing of an integrated anti-aircraft fire control requires that provision be made for simulating input to the radar receiver. The simplest expedient would be to generate a suitable error signal for insertion at the tracking servo inputs. However, this method of testing would not yield information about performance of such important elements of the radar as angle-error detection circuits and automatic gain control.

Feasibility of inserting the test signal at radio frequency has been considered. Because the microwave circuits do not contribute directly to dynamic response of a fire-control system, the greater complexity of radio frequency insertion, as compared with intermediate frequency insertion, did not appear justified. Development of a transducer which will synthesize a suitable intermediate frequency signal for testing conical scan fire control radars has accordingly been initiated.

Concurrently with development of the dynamic tester, Melpar, Inc., will develop auxiliary equipment for preparing magnetic problem and answer tapes from binary coded tapes obtained from existing computational facilities of the Ordnance Corps. Delivery of a demonstration model of the dynamic tester, including intermediate frequency radar insertion unit and three channel error recorder is scheduled for delivery by April 1956.

In addition to developing a dynamic tester suitable for use in engineering studies of fire-control systems at proving grounds or service boards, feasibility of designing a simplified version for field use is to be considered by the contractor.

Automatic Assembly.—Increasing use of printed-circuit panels has led to development of mechanized assembly techniques. Circuit modules for computers required in the air-defense system being built by the U. S. Air Force are assembled on Autofab equipment developed by General Mills, Inc. An Autofab machine controlled by 3 operators can turn out 1,200 circuits an hour. Manual methods would require 135 operators.

Autofab assembly machines can accommodate panels ranging from 2 by 2 inches to 10 by 10 inches. Longer panels can be accommodated in multiples of ten inches. Auxiliary machines for forming leads and loading magazines (Autoprep) and for automatic inspection (Autotest) are also being developed by General Mills.

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ROCKETS AND GUIDED MISSILES

Alfred J. Zaehringer

Missiles.—Official disclosures during the past few months are indicative of America's growing family of missiles. Many are in or near operational status.

Nike, one of our first operational missiles, is now sited at over 100 locations throughout the country. Expanded production of Nike is to take place at the new Douglas Aircraft Charlotte (N. C.) Division in 1956. Currently being produced at Santa Monica, Calif., Nike has successfully completed its cold-weather testing in joint U. S.-Canada tests near Fort Churchill, Canada. Announcements of AEC tests in Nevada indicate that Nike and possibly other missiles will be armed with nuclear warheads for air defense.

Honest John, another Army Ordnance weapon, is available in operational numbers in America and Europe. This ground-to-ground ballistic missile is powered by a large solid-propellant rocket motor, weighs about 3 tons, is 30 inches in diameter, and is about 27 feet long. Meanwhile, improvements for Honest John are in the works.

Yet another Army Ordnance weapon nearing production is the ground-to-ground *Redstone*. Production tooling is taking place in a Chrysler Corporation plant near Detroit.

In a new move the Air Force has grouped its missile family into tactical, strategic, and air-defense groups and will no longer use the pilotless aircraft designation. The tactical missile, Martin *Matador* TM-61, has been deployed in Europe. The Northrop *Snark* SM-62 strategic missile is undergoing flight tests at Cocoa, Fla. Snark, turbojet-powered, is a high-speed, long-range missile using an inertial guidance system.

Partial wraps were taken off the Bell *Rascal* GAM-63 guided aircraft missile. An air-to-ground weapon, Rascal is carried to the vicinity of its target by a "mother" airplane—probably a B-36 or B-47 for now and later by a B-52 or B-58—and air launched much in the same manner as the launching of the Bell X-1 rocket airplane.

Rascal gets its power from rocket engines, and speeds of near 1,000 miles an hour have been reported. Guidance for Rascal comes from the mother ship.

Potent new armament is scheduled for the Northrop F-89 Scorpion and the delta-winged Convair F-102 with the Hughes *Falcon* GAR-98 guided aircraft rocket. Falcon, which is automatically guided to its target, has a diameter of 6 inches, is about 6 feet long, and weighs approximately 100 pounds.

Propulsion for Falcon, an air-to-air missile, comes from a high-performance solid-propellant rocket motor giving the "bird" supersonic speed and a range of several miles. Homing guidance within the missile assures an effective weapon.

The Boeing *Bomarc* IM-99 interceptor missile, combines rocket and ramjet power plants. Take-off is vertical with a rocket engine supplying powerful thrust while two ramjets provide cruising thrust for long ranges. The ground-to-air Bomarc is now in the development stage.

In addition, two new long-range missiles are beginning to emerge. The North American *Navaho* SM-64 surface-to-surface missile is rocket-launched and cruises at 75 to 90 thousand feet altitude with its ramjets at a high supersonic speed. Navaho is described as being in the long-range class.

Also in the long-range category is the Convair *Atlas*, an intercontinental ballistic missile. Atlas, completely rocket-powered, may be designed to deliver a nuclear bomb at a range of up to 5,000 miles in about 30 minutes.

Propulsion.—Look to the increased use of solid rocket propellants in our propulsion spectrum. Maj. Gen. Leslie E. Simon, Assistant Chief of Army Ordnance, early this year stated that large, temperature-insensitive solid-propellant grains were now possible. Echoing this statement, H. W. Ritchey, technical director of Thiokol Chemical Corporation, Redstone Division, said that, in conjunction with new grain-to-case bonding techniques, it is now possible to produce single grains of almost unlimited size.

General Electric, meanwhile, is expected to release more data about its statement made last year that G. E. has conducted flight tests of the largest solid-propellant rocket ever built. Largest U. S. grain produced during World War II was about 500 pounds. Biggest World War II solid-propellant rocket was the German *Rheinbote* which used nearly 1,300 pounds of propellant to give it a range of over 125 miles. *(Continued on p. 126)*

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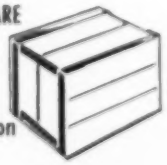

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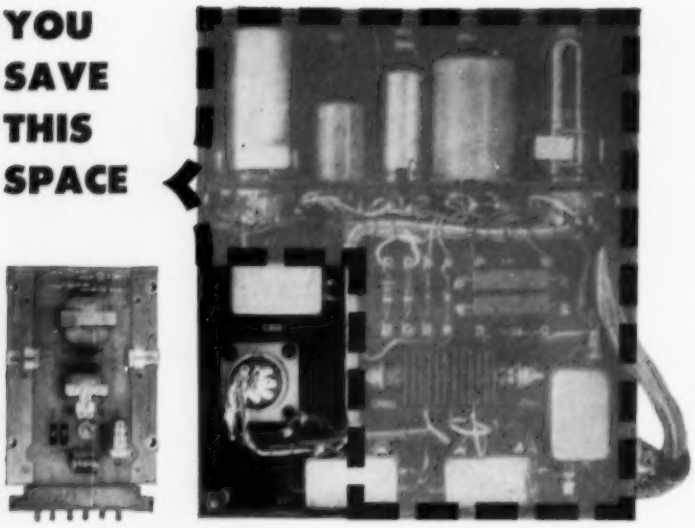

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Rockets and Guided Missiles

Guidance.—Much progress is being made in the guidance and control of our new missiles. Tests with *Falcon* and *Sparrow* indicate that accurate guidance systems can be built into the confined spaces available. Beam-rider guidance, although somewhat limited in operation and subject to countermeasures, has proved successful in both domestic and foreign operational missiles. One British antiaircraft missile uses an infrared seeker.

For longer ranges—particularly for intercontinental cruise missiles—inertial systems such as the star tracker have promise as a jam-free method. Command guidance techniques, with radar trackers and computers on the ground, may prove valuable for medium-range missiles. The problems associated with the guidance of the long-range ballistic missile, however, may be solved by the development of smaller airborne computers.

The importance of guidance in current missile development was revealed by a Department of Defense statement that forty to fifty per cent of the missile cost in development is due to electronic equipment. In production, however, this cost may drop to thirty-five per cent.

If we are to maintain leadership in electronic control systems, Louis Fox, chairman of the board of directors of the California Aircraft Parts Manufacturers Association, asks that the Government establish a practical program for the design and development of new electronic equipment. Our guidance demands are ever increasing with new missiles, and also to be taken into consideration is the long time required to prove out new components.

Research.—The Martin *Viking* No. 12 recently reached an altitude of 144 miles over White Sands. Purpose of the firing was to study the ionosphere and the effects of aërodynamic heating at high speeds. Viking will be fired this summer near Norwegian waters to study the atmosphere in northern climes.

Snort is the name of the Supersonic Naval Ordnance Research Track at Inyokern, China Lake, Calif. The track, 4.1 miles in length, is of heavy-duty, reenforced concrete with precision-aligned rails. Snort is to be used for captive flight testing of aircraft models, missiles, etc., at speeds ranging into the supersonic. Built to bridge the gap between wind-tunnel and free-flight testing, it affords laboratory conditions and intact recovery of test items.

Items tested on Snort are mounted on either monorail or dual-rail carriages which ride on metal shoes. Test carriages are accelerated to the required velocity by combinations of rocket motors.

Maximum accelerations of 100 G's can be achieved with speeds of up to 3,500 feet a second. At the end of the run a water brake is used to stop the vehicle.

Converter ends engine stalling on the job

Eimco Corporation reports it's impossible to stall the Eimco 105 tractor engine through its Allison TORQMATIC Converter.

That means the crawler delivers its full 45,000-pound drawbar pull even at a standstill—means it can handle bigger loads than other tractors of equal power not equipped with a torque converter.

But greater working ability is just one of the many operating advantages the TORQMATIC Converter, in combination with Eimco's transmission, brings to this new crawler. It eliminates the master clutch and clutch pedals, permits instant reversing at all speeds.

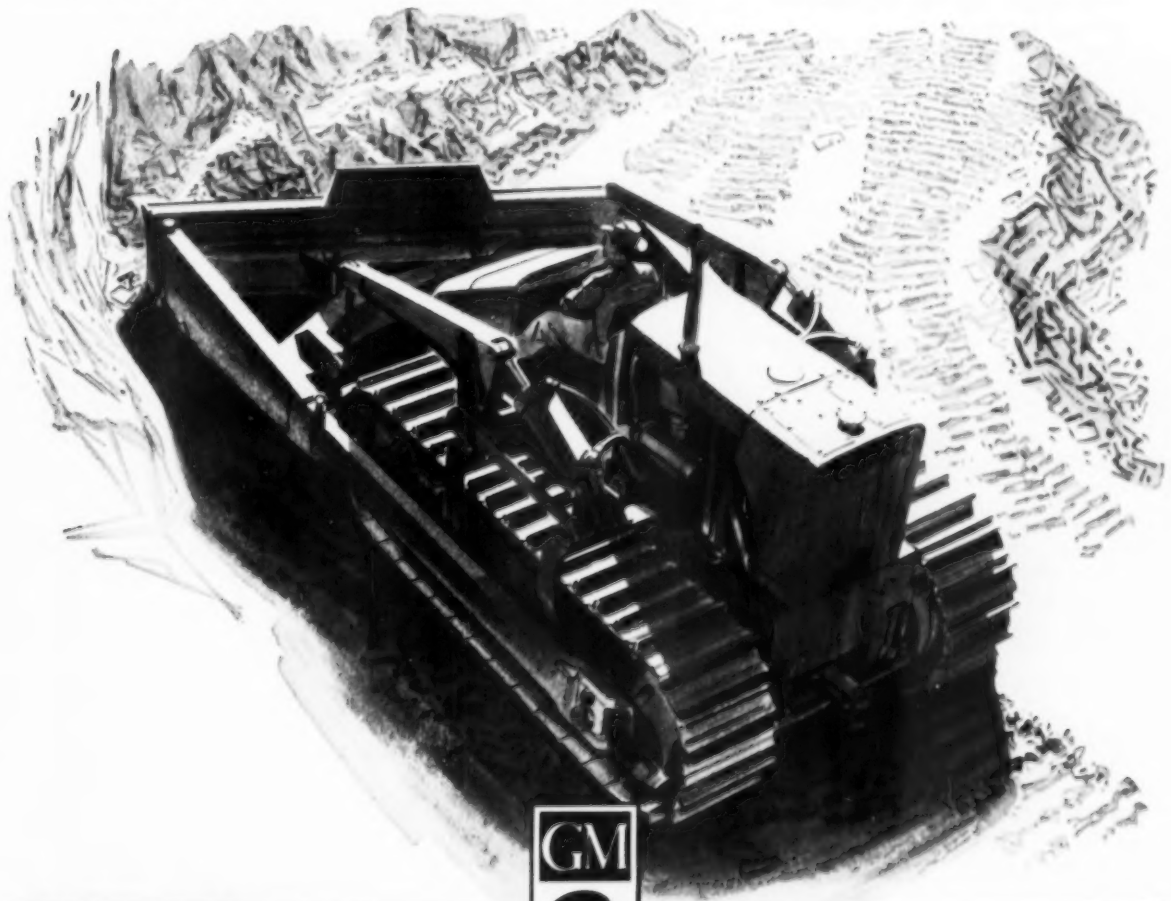
It reduces operating costs by continually matching tractor speed to the load, multiplying engine torque output, holding the power to the load at all times.

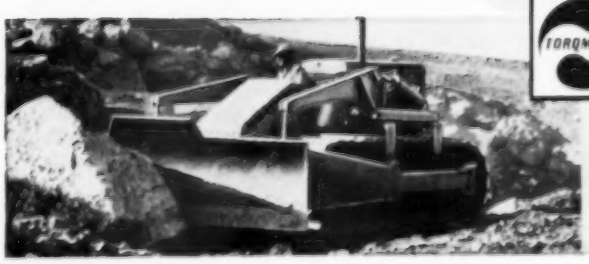
It increases the life of gears, bearings, shafts and engine by transmitting power smoothly, protecting engine and driveline components from harmful shock loads, preventing engine lugging or stalling.

And it gives the Eimco 105 an infinite number of speeds within its operating range with only four control-lever positions—two forward and two reverse.

The Eimco Corporation describes the Allison TORQMATIC as the "finest fluid converter." It's a key component in a tractor that cost over $5,000,000 to develop.

You'll find Allison TORQMATIC Converters and TORQMATIC Transmissions used in a wide range of heavy-duty equipment made by many leading manufacturers. TORQMATIC Converters fit gasoline or Diesel engines from 40 to 400 horsepower. TORQMATIC Transmissions can handle up to 300 horsepower. Ask your equipment dealer or manufacturer about Allison TORQMATIC DRIVES next time you buy—or get more information by writing Allison Division of General Motors, Box 894W Indianapolis 6, Indiana.





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RECENT PATENTS

This department on recent military-industrial patents is being published in ORDNANCE *to keep our readers informed of the latest developments in these fields. The data are compiled by Melvin Nord, patent attorney, Detroit, Mich. Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each.*—THE EDITORS.

INITIATOR CARTRIDGE

• *U. S. Patent No. 2,700,336. Issued January 25, 1955, to George P. Sillitto and James B. Howat. Assigned to Imperial Chemical Industries, Ltd.*—This patent relates to blasting cartridges containing a blasting charge of sodium nitrite and ammonium chloride with one to three per cent of anhydrous sodium carbonate or magnesium oxide as stabilizer. The object is to reduce the time between application of the firing current and the blast. According to the inventors, their method reduces this time from 0.1—1 second to 20—50 milliseconds.

Two black-powder charges initiate the decomposition of the main charge practically simultaneously at two widely separated points, thereby eliminating the time required for the decomposition to travel through the main charge.

The firing current passes through terminals and ignites the fusehead which in turn ignites the black-powder charge and the instantaneous fuse which simultaneously ignites the slightly faster burning black-powder charge. The two black-powder charges are consumed substantially at the same time and simultaneously start the decomposition of the main charge at two separate points.

EXPLOSIVE COMPOSITION

• *U. S. Patent No. 2,704,706. Issued March 22, 1955, to Ludwig F. Audrieth. Assigned to Olin Mathieson Chemical Corporation.*—This invention provides a method of increasing the sensitivity of ammonium nitrate explosives by the addition of a small amount of hydrazine mononitrate. Mixtures containing up to one per cent of hydrazine nitrate (on the basis of the ammonium nitrate content) can be fused into a homogeneous mass which, upon solidification, yields crystals of ammonium nitrate-hydrazine nitrate complex. This increases the detonation rate as well as the sensitivity. If it is desired to increase the sensitivity alone, granular ammonium nitrate may be coated with up to ten per cent of hydrazine mononitrate.

HELICOPTER UNDERCARRIAGE

• *U. S. Patent No. 2,702,171. Issued February 15, 1955, to Edward F. Katzenberger. Assigned to United Aircraft Corporation.*—When a helicopter comes to rest on the ground or on the water as shown in Figure 1 (top), the weight of the helicopter will cause the rear strut to

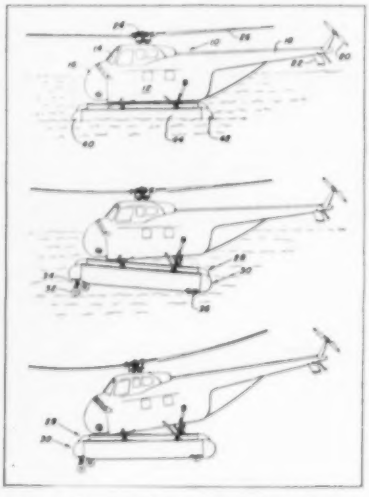

Fig. 1. Strut action at varying attitudes.

be compressed during which the shock of a hard landing will be absorbed. As the helicopter rides in rough water this action will also absorb some of the motion due to swells and will allow the rotor shaft to remain substantially perpendicular to the surface of the water. Likewise much of the difficulty of landing a float-equipped helicopter in choppy water is eliminated by the presence of these struts.

In taking off from either land or water, as the weight of the helicopter is removed from the struts, they extend into the position shown in Figure 1 (center). The extension of the struts in their unloaded

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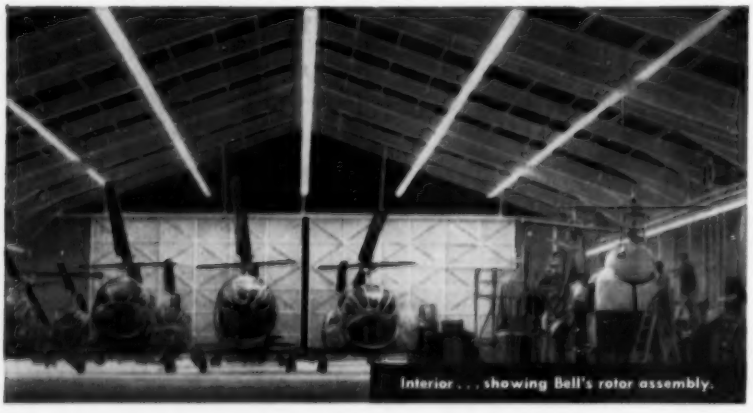

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Recent Patents

condition is arranged to be such that in the normal forward flight of the helicopter, in which the rotor shaft axis as well as the tip path plane of the blades is inclined somewhat forward, the floats are carried in substantially horizontal or parallel relationship to the relative wind as is illustrated in Figure 1 (bottom) thus eliminating a severe nose-down pitching moment which would otherwise occur if the floats were carried rigidly by the fuselage at an angle to the relative wind.

This greatly reduces float drag and also avoids the difficult control problems which arise upon substantial changes of pitching moment of the airframe due to the floats.

SURGE ELIMINATOR

• *U. S. Patent No. 2,700,871. Issued February 1, 1955, to S. W. Crawford. Assigned to General Electric Company.*—This invention provides a method for eliminating disastrous surges in the fuel line of a rocket motor when the fuel supply is shut off, and it does so without the use of a surge tank.

The method is simplicity itself. All that is done is to provide a by-pass line for returning excess fuel back to the vapor space of the fuel tank. A check valve in this line prevents reverse flow. When the fuel valve is shut off, the temporary surge of excess pressure is relieved through the check valve and back to the fuel tank.

ANTISWEEP DEVICE

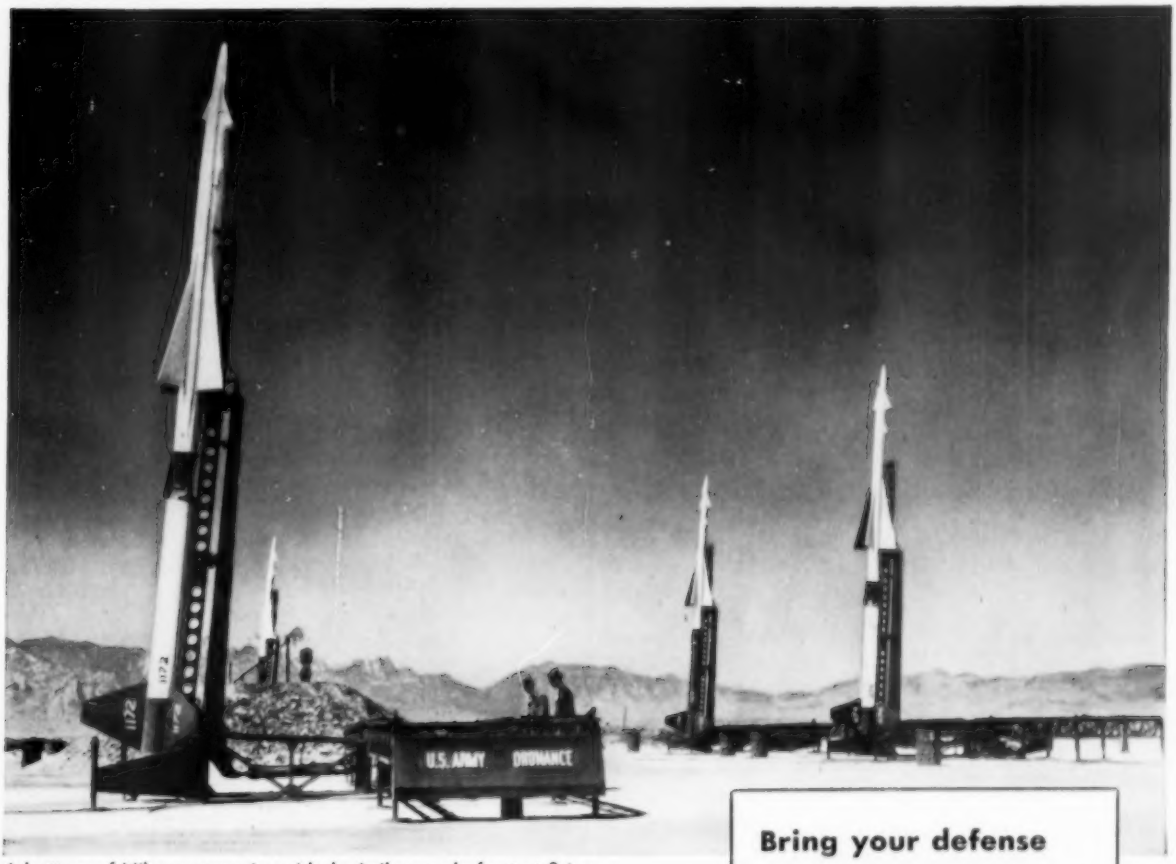
• *U. S. Patent No. 2,702,003. Issued February 15, 1955, to Ellis A. Johnson.*—This invention provides a means for preventing the explosion of a submarine mine by the electric current set up in sea water by a sweep cable or sweep tail towed by a vessel. Instead, the current set up in the water by the sweep cable operates a sensitive relay which disarms the mine for a period of time sufficient to prevent the firing of the mine.

PRIMING COMPOSITIONS

• *U. S. Patents No. 2,702,745 and 2,702,746. Issued February 22, 1955, to Joseph F. Kenney. Assigned to Remington Arms Company.*—These two patents describe a number of styphnate compositions which are useful as priming mixtures for small-arms ammunition. For example: 36 per cent normal lead styphnate, 4 per cent tetrazene, 10 per cent potassium styphnate, lead styphnate, lead hypophosphite, and 50 per cent barium nitrate.

ROTATING PARACHUTE

• *U. S. Patent No. 2,701,697. Issued February 8, 1955, to Edgar G. Ewing. Assigned to Radioplane Company.*—This invention provides a parachute which rotates rapidly when in use, thereby eliminating side-to-side motion and increasing its directional stability.



A battery of Nike supersonic guided missiles ready for test firing.

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Until recently guided missile booster casings... like Egyptian mummies... were swathed in yards and yards of narrow wrap-around fabric. It's almost impossible to achieve a perfectly uniform, even surface with such an overlapping method.

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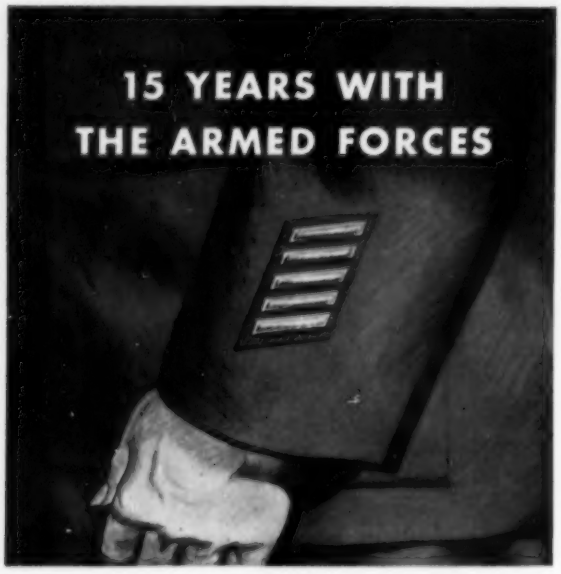

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Book REVIEWS

Reviews in this issue by:

F. W. Foster Gleason, *military historian, ordnance analyst, editor, Washington, D. C.*

Leo A. Codd, *editor,* Ordnance *magazine, Washington, D. C.*

Orville C. Shirey, *major, Infantry, United States Army Reserve.*

Brig. Gen. H. N. Toftoy, U.S.A., *guided missile and rocket expert, engineer, author, Huntsville, Ala.*

Brig. Gen. Thomas K. Vincent, U.S.A., Ret., *artillerist, engineer, author, Washington, D. C.*

Capt. J. M. P. Wright, U.S.N., Ret., *naval ordnance engineer, logistician, editor, Washington, D. C.*

A Military History of the Western World, Vol. II. By Maj. Gen. J. F. C. Fuller. New York: Funk and Wagnalls. 651 pp. $6.

THIS is the second volume of General Fuller's massive historical work on the decisive battles of the Western world and their influence upon history. Volume II describes and analyzes the nineteen major battlefield engagements from the defeat of the Spanish Armada in 1588 to and including the Battle of Waterloo, 1815. Specifically in the author's words the scope of this volume is described as follows:

"The wars discussed in this book may be divided into three geographical groups: those which from the earliest times to the Battle of Lepanto in 1571 were mostly fought in the Mediterranean lands and southwestern Asia; those which from then on to the Battle of Waterloo were for the most part fought in the lands bordering or dependent upon the Atlantic; and those which since 1815, because of the progress of industry, science, and locomotion, have claimed increasingly the whole world for their stage."

Here are included the names of battles and of military leaders which stand prominent in the history of mankind. With his superb skill as military historian, General Fuller in broad strokes and with infinite detail presents crucial operations so that the military student can envisage not only movements of forces but their significance as they resulted in victory or defeat.

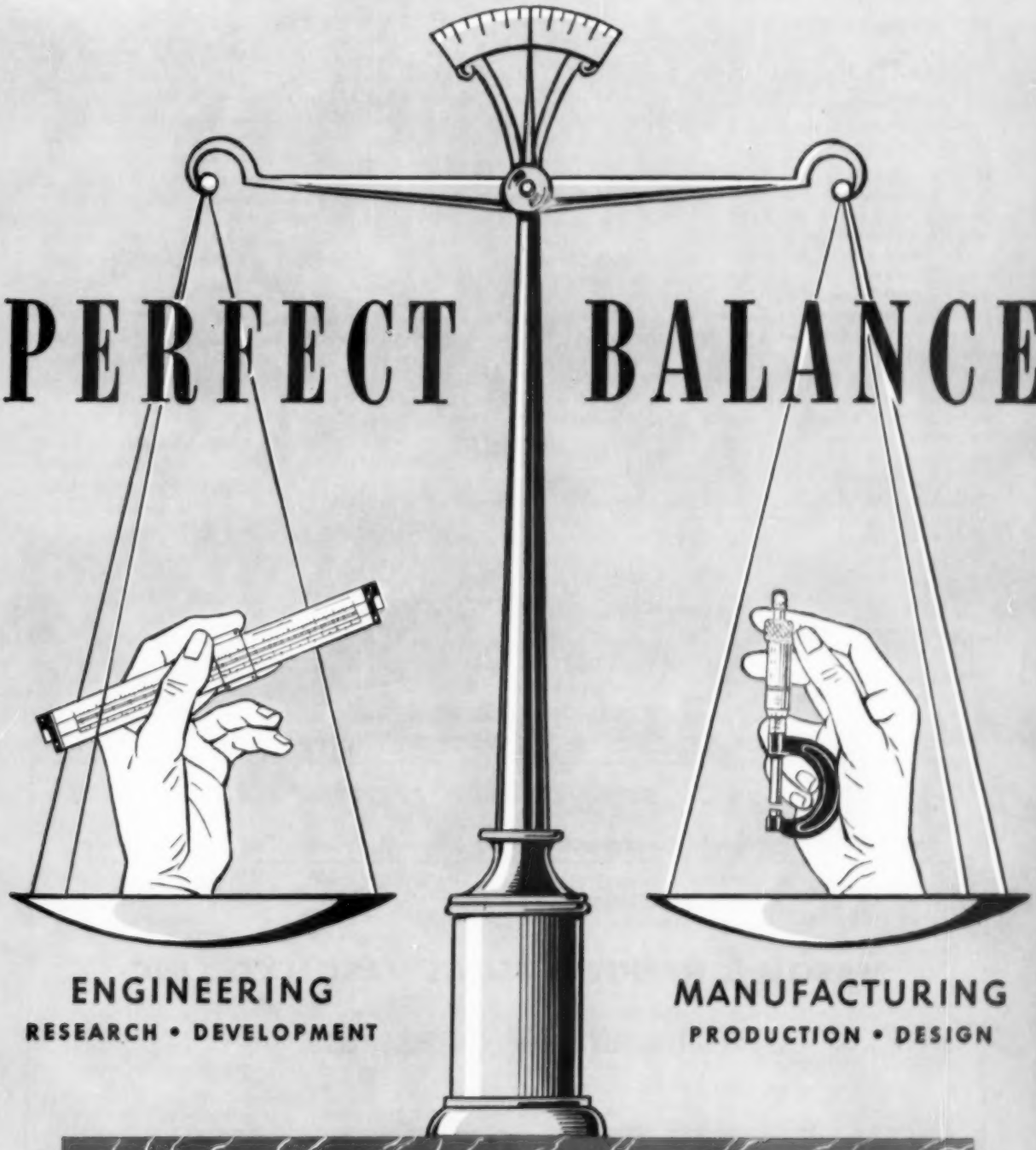
The same high caliber of composition, style, and treatment which marked the first volume is apparent on every page of the second. Here is brilliant writing by a renowned soldier-historian whose life and work with pen and sword have brought him well-merited acclaim.

As in Volume I, the periods between the battles described are depicted in short "chronicles" so that the reader is enabled to visualize the spirit of the times as well as the political, economic, and religious conditions which culminated in open conflict. Thirty-three maps and plans are included.

For the student of American military history, General Fuller's analyses of the capitulation of Saratoga, the Battle of the Chesapeake, and the siege of Yorktown will be read with particular understanding.

Volume III, which is to follow, will complete the presentation. It will cover the period from the Battle of Waterloo to the Battle of Leyte Gulf, 1944.—Leo A. Codd.

PERFECT BALANCE



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Book Reviews

The Untold Story of Douglas MacArthur. By Frazier Hunt. New York: Devin-Adair Company. 533 pp. $5.

DESPITE the many volumes on the Pacific and Korea, this splendid compilation by a noted war correspondent is a notable contribution to some of the most pressing questions with which our Nation is faced. The author began his friendship with MacArthur in the First World War. That officer had just organized the famed "Rainbow Division" (his own idea throughout) and had become its chief of staff. Hunt's book is crowded with history in outline, competently and vividly recorded, but its prime purpose remains the story of one of America's greatest soldiers and statesmen.

It was when MacArthur fought the breakup of the "Rainbow" (much as Pershing later fought the breakup of the entire A.E.F.) that he first provoked the enmity of several ambitious officers. It was the first, but not the last occasion in which devotion to the Army and to principle would bring him bitter personal enmities.

He was among the first to grasp the then-new concept of "defense in depth." As the result of a splendid battle record as a brigadier general, he was well started on his way to enduring fame.

MacArthur's part in the desperate struggle in the Philippines is thrillingly told as is the saving of the Australian Commonwealth, the brilliant strategy of the long counteroffensive, with a minimum of force and supply, and the long fight at last to fulfill his pledge, "I shall return." Standing above all, was the nigh-incredible economy of casualties, made possible by MacArthur's dictum—"Hit 'em where they ain't!"

The Japanese occupation and the abandonment of China are well recorded. The story of the Korean War, a struggle that MacArthur was not permitted to win and the first in U. S. history which did not end in victory, ends with a short account of MacArthur's recall and his return to his homeland. That he was genuinely amazed at the immense throngs which turned out to greet him but demonstrates his complete isolation in the Far East.

Frazier Hunt's book does not offer a definitive biography, but it does answer many a puzzling question as to the present parlous position of the Far East. And it presents a competent portrait of a very great American.—F. W. FOSTER GLEASON.

Psychological Warfare. By Paul M. A. Linebarger. Washington: Combat Forces Press. 318 pp. $6.

THE first edition of this book has been the key text for use by students of psychological warfare for the past decade. The advances in the art as a result of the Korean war and the additional techniques developed from World War II, plus a complete exhaustion of the stocks of the first edition, has caused the author to expand his previous work.

The fundamentals contained in the earlier chapters of the first edition have been retained, but, prophetically perhaps, the chapter on "Psychological Warfare and Disarmament" has been deleted and replaced by several chapters containing new data.

This book remains the paramount text on this subject. If psychological warfare is your vocation or your avocation you need this book.—T. K. VINCENT.

Realistic Combat Training. By Lieut. Col. Robert B. Rigg. Harrisburg: Military Service Publishing Company. 239 pp. $3.50 cloth, $2.75 paper.

THIS book is oriented toward the men responsible for the training of Infantry, Artillery, and Armor units. It is packed with useful ideas for injecting the sights, sounds, and shocks of combat into their training, from maneuvers down to the simplest platoon problem or foot march.

However, these aids to realistic training, which the author has explained and illustrated in sufficient detail to permit them to be duplicated or elaborated upon,

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INDEX TO ORDNANCE VOLUME XXXIX

• The Index to Volume XXXIX of ORDNANCE, with title page for binding, will be available shortly. It will be sent free of charge upon request to the Editorial Offices at the address below.

• This Index covers subjects in the following 1954 and 1955 issues:

July-August (No. 205)
September-October (No. 206)
November-December (No. 207)
January-February (No. 208)
March-April (No. 209)
May-June (No. 210)

• The Index is arranged alphabetically by subject and author and makes a handy reference to all the items published in ORDNANCE during the past volume year. In binding Volume XXXIX a copy of the Index should be placed before the first issue.

• Members who wish to receive copies of the Index each year may request to be placed on the mailing list for this purpose and no further notice will be necessary. Those who have already so requested will receive their copy in due course.

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Book Reviews

can as well be applied to Ordnance, Quartermaster, Chemical, and other so-called service units.

This reviewer holds a strong conviction that it is a duty of commanders of such units to give their men all the combat-type training possible. In a war of rapid movement, any unit, including the legendary Mess Kit Repair Company, may find itself in combat. The contents of Colonel Rigg's book, intelligently applied to training, will help all units to be ready for it.

Colonel Rigg has done a splendid job, but we regret we cannot say the same for his usually excellent publisher. This book has been designed with an eye to getting the most words into the least possible space. The reader has his task made very difficult by the small type, the crowded, unattractive page, and the glaring, coated paper. The importance of the subject deserves better treatment.—ORVILLE C. SHIREY.

Modern Physics for the Engineer. Edited by Louis N. Ridenour. New York: McGraw-Hill Book Company. 499 pp.

DR. RIDENOUR has presented the engineer with an amazingly broad coverage of physics as it is known today. Collected together under one cover are the talks by a leader in each field of physics as presented to engineering sessions at the University of California.

Here you will find the latest concepts of the relationships among Einstein's theories and quantum mechanics and how they enter studies of atomic structure and the universe. Some talks are difficult to follow if one has not kept up to the minute on such subjects as transistor theory or physics of the solid state.

All engineers should take a fling at these papers as a challenge to their knowledge of advances in physics that are, or soon will be, affecting their individual professions.—J. M. P. WRIGHT.

France: The Tragic Years—1939-1947. By Sisley Huddleston. New York: Devin-Adair Company. 360 pp. $5.

IN late months not a few books have dealt with the collapse of the Third Republic. Huddleston presents a fresh, almost a novel viewpoint. English-born, yet a lifelong resident of France, he combines deep knowledge with a certain amount of detached outlook. As a correspondent for English and American journals he had observed the wild gyrations of European policies. The result is a stirring and thought-provoking account of the war, occupation, and liberation.

He resided, till the defeat of the Allied forces, in a Normandy village but spent the occupation years in Monaco. The author was one of the few who foresaw the grave dangers of Communist opportunism, being warned by the Liberal Front propaganda of Spanish Civil War days.

A realistic appraisal of the impossibility of effective aid to Poland, and the ghoulish avidity with which the Soviets joined Hitler in its destruction, is reflected in his cogent writing. Huddleston unmasks the falseness of much of the resistance movement and gives a fully documented account of the ghastly slaughter of more than 100,000 men and women in the revenge-ridden purges that followed liberation.—F. W. FOSTER GLEASON.

The Gyroscope Applied. By K. I. T. Richardson. New York: Philosophical Library. 384 pp. $15.

THE author accomplishes his purpose of describing the gyroscope, its basic principles, and many gyroscope applications in a very clear and well organized manner. No attempt is made here to go deep into gyro theory and practice, and the present-day high-precision gyroscopes being developed for many applications are not discussed. However, the appendix sets forth mathematically the fundamental laws of the gyroscope and illustrates the solving of simple problems in this field.

The first section of the book explains the basic principles of the gyroscope. The other sections describe many applications of the gyroscope and illustrate and explain the instruments used in these applications in the marine, aëronautical, military, and other fields. Applications of gyroscopes are inclued up to the end of World War II.—H. N. TOFTOY.

BOOKS RECEIVED

ASTM Standards on Electrical Insulating Materials (with related information). Prepared by ASTM Committee D-9 on Electrical Insulating Materials. Philadelphia: American Society for Testing Materials. 642 pp. $5.50.

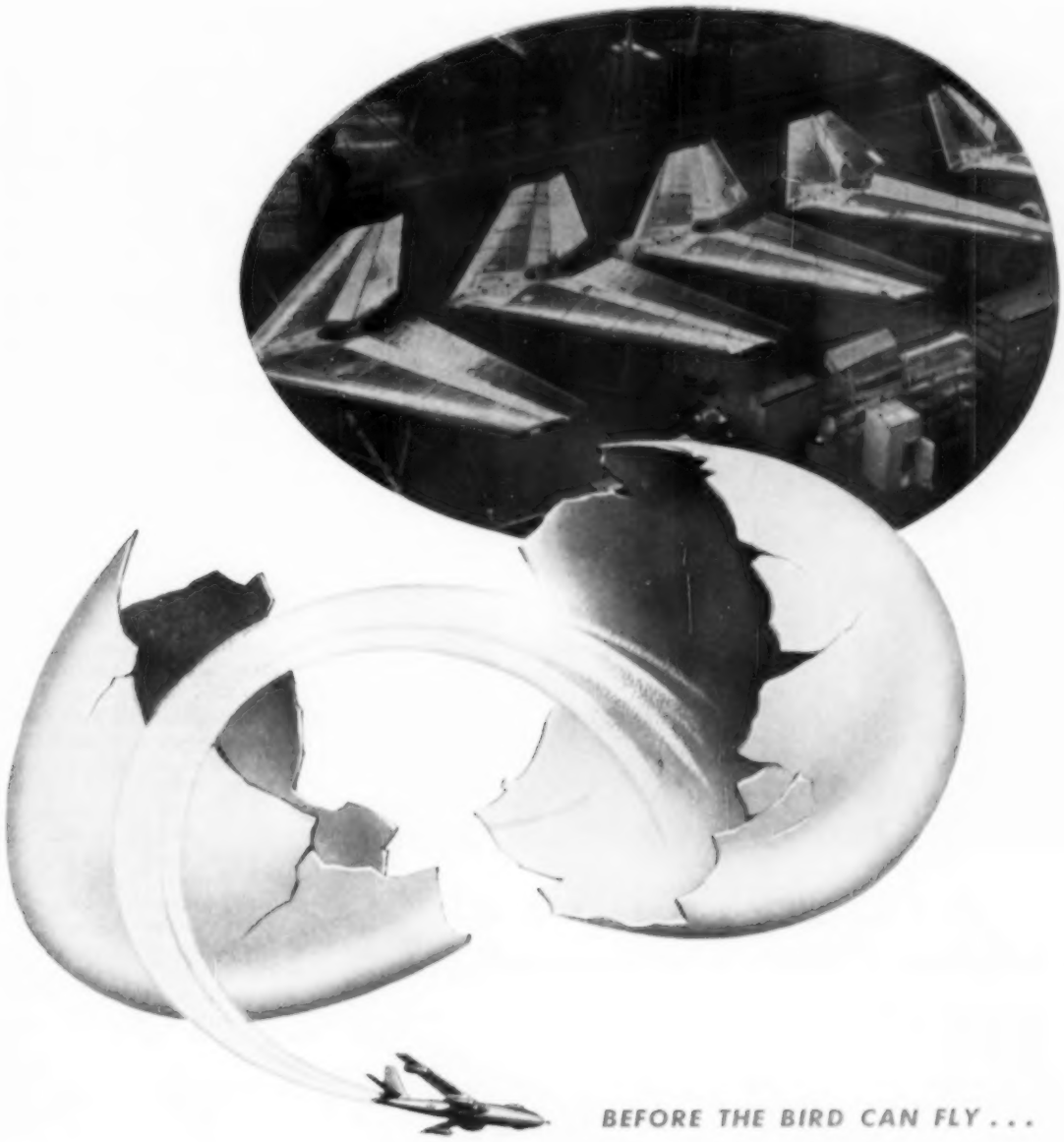
Atomic Science, Bombs and Power. By David Dietz. New York: Dodd, Mead & Company. 316 pp. $4.50.

Automation Dictionary. Minneapolis: Brown Instruments Division, Minneapolis-Honeywell Regulator Company. Obtainable on request.

Catalog of the Henry Huddleston Rogers Collection of Ship Models. Compiled by the U. S. Naval Academy Museum. Annapolis: U. S. Naval Institute. 117 pp. $2.

Computer Development (SEAC and DYSEAC) at the National Bureau of Standards. National Bureau of Standards Circular 551. Washington: U. S. Government Printing Office. 146 pp. $2.

The Defense Materials System in Our



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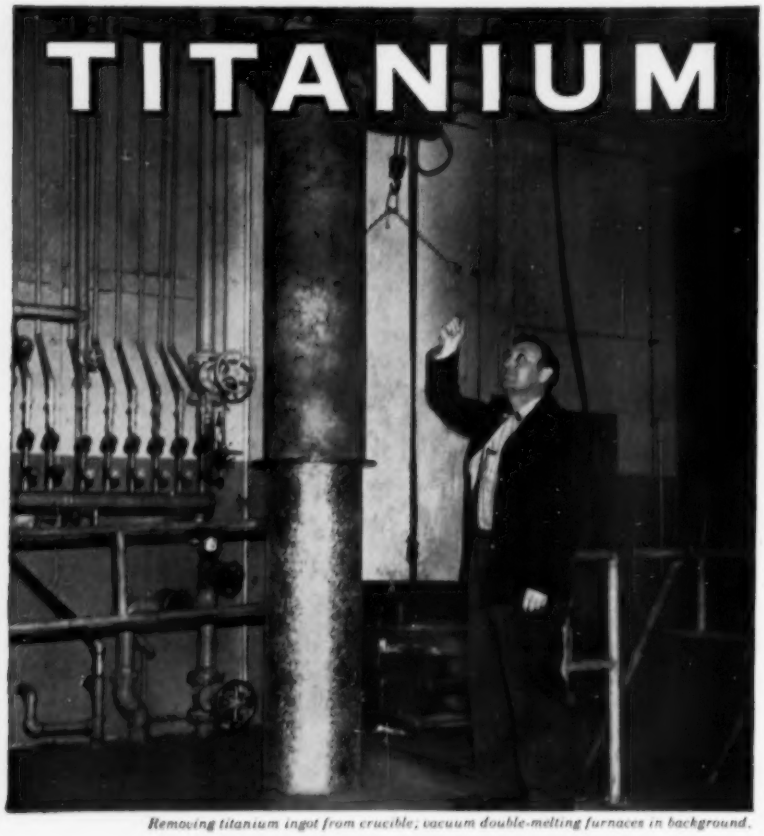

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MALLORY Ti SHARON

Book Reviews

American Industry. U. S. Department of Commerce. Washington: U. S. Government Printing Office. 41 pp. $0.25.

Dimensions and Tolerances for Mass Production. By Earle Buckingham. New York: The Industrial Press. 164 pp. $8.

The Exploration of the Moon. By R. A. Smith. New York: Harper & Brothers. 112 pp. $2.50.

Fatigue of Aluminum. By R. L. Templin. H. W. Gillett Memorial Lecture, 1954. Presented before the Fifty-seventh Annual Meeting of the American Society for Testing Materials. Philadelphia: American Society for Testing Materials. 59 pp. $1.50.

Flight Handbook. Edited by Maurice A. Smith. Fifth Edition. New York: Philosophical Library. 282 pp. $6.

Geography of the Northlands. Edited by George H. T. Kimble and Dorothy Good. New York: John Wiley & Sons, Inc. 534 pp. $10.50.

Helical Spring Tables. By John D. Gayer and Paul H. Stone, Jr. New York: The Industrial Press. 165 pp. $5.

How To Train Engineers in Industry. Prepared and published by Professional Engineers Conference Board for Industry in coöperation with the National Society of Professional Engineers. Washington: 72 pp. $2.

Interpretation of Engineering Data. By Harold F. Dodge. Edward Marburg Lecture, 1954. Presented before the Fifty-seventh Annual Meeting of the American Society for Testing Materials. Philadelphia: American Society for Testing Materials. 36 pp. $1.50.

A Long Line of Ships. By Lieut. Comdr. Arnold S. Lott, U.S.N. Annapolis: U. S. Naval Institute. 268 pp. $4.95.

The New Official Gun Book. Sixth Edition, 1955-1956. Edited by Charles R. Jacobs. New York: Crown Publishers. 227 pp.

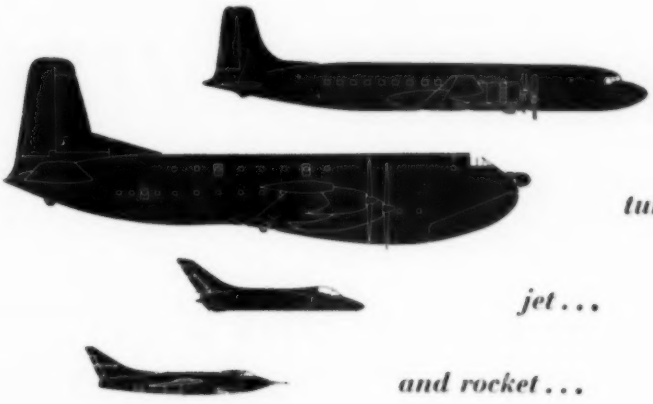
An Outline of Atomic Physics. By Oswald H. Blackwood, Thomas H. Osgood, Arthur E. Ruark. New York: John Wiley & Sons, Inc. 501 pp. $7.50.

Principles of Personal Finance for Service Personnel. By associates in the social sciences, Department of Social Sciences, U. S. Military Academy, West Point, N. Y. Harrisburg: Military Service Publishing Company. 178 pp. $1.50.

Problems of the Thermal Barrier. Papers reprinted from *Mechanical Engineering* for December 1954. New York: New York University Press. 12 pp. Available upon request.

Sicily-Salerno-Anzio. By S. E. Morison. Boston: Atlantic-Little Brown. 413 pp. $6.

Vision in Metrology. By Louis Polk. Dayton: Sheffield Corporation. 16 pp.



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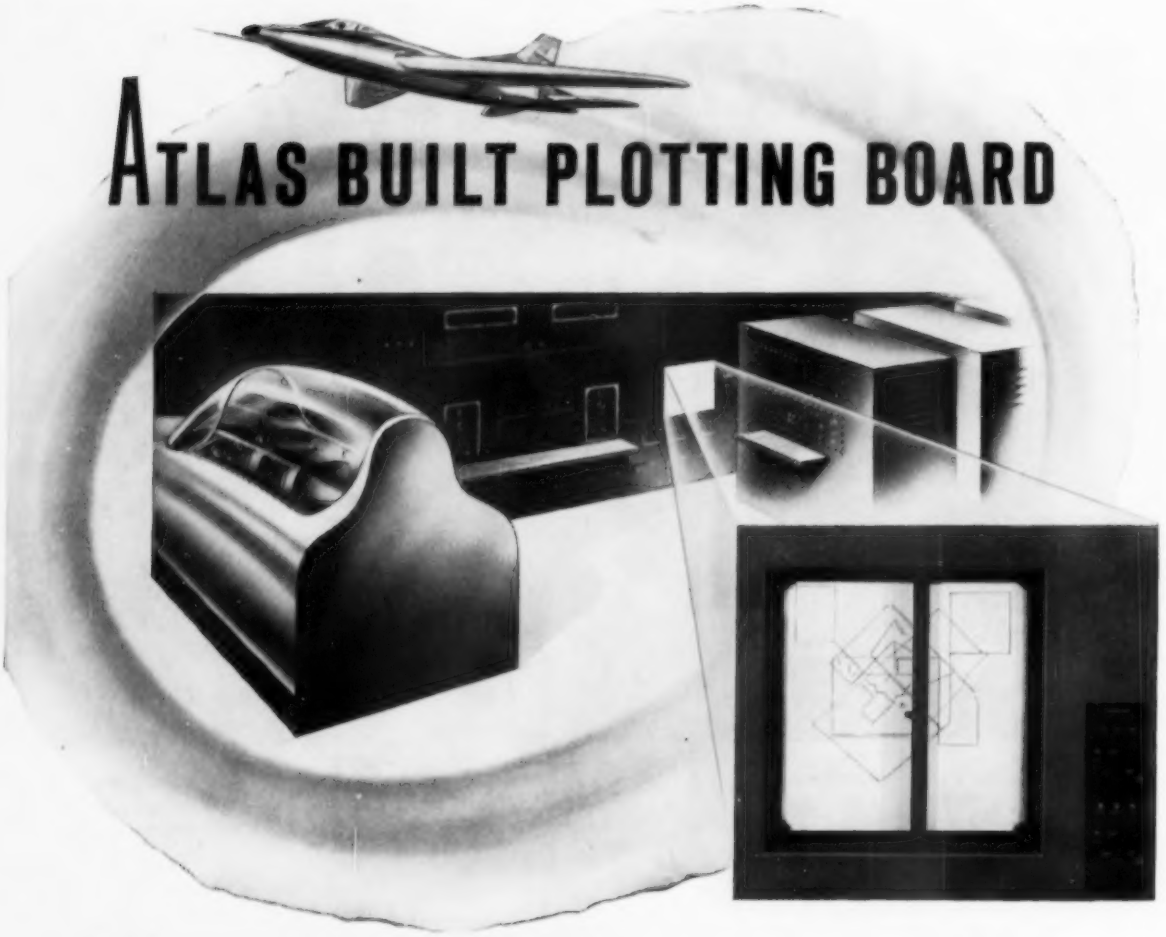
ATLAS BUILT PLOTTING BOARD



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Honorable JOHN W. BRICKER
Speech in the Senate of the United States
August 5, 1954

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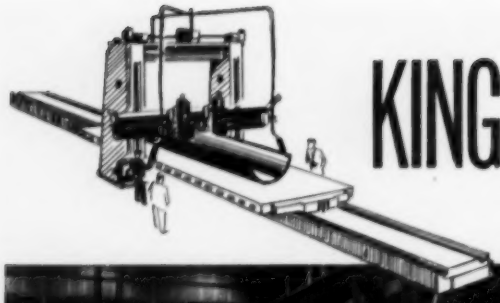
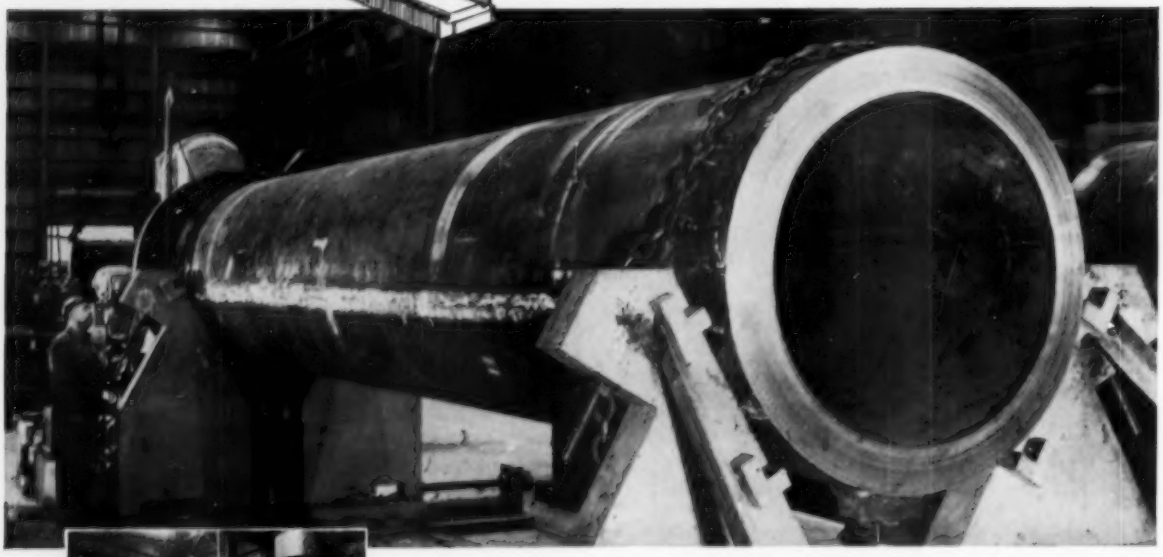
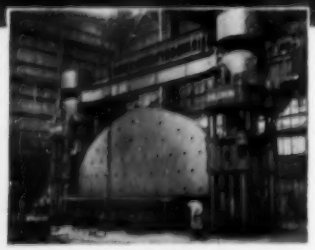


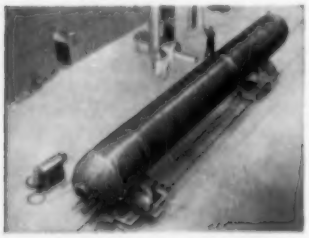
KING SIZE PRESSURE VESSELS





This 8,000 ton hydraulic beam press at Mountaintop can bend steel plate 39 ft long and up to 9 inches thick.

Twin-arc welding units on traveling booms permit welding of vessels up to 8 inches thick, 12 ft in diameter and any desired length.



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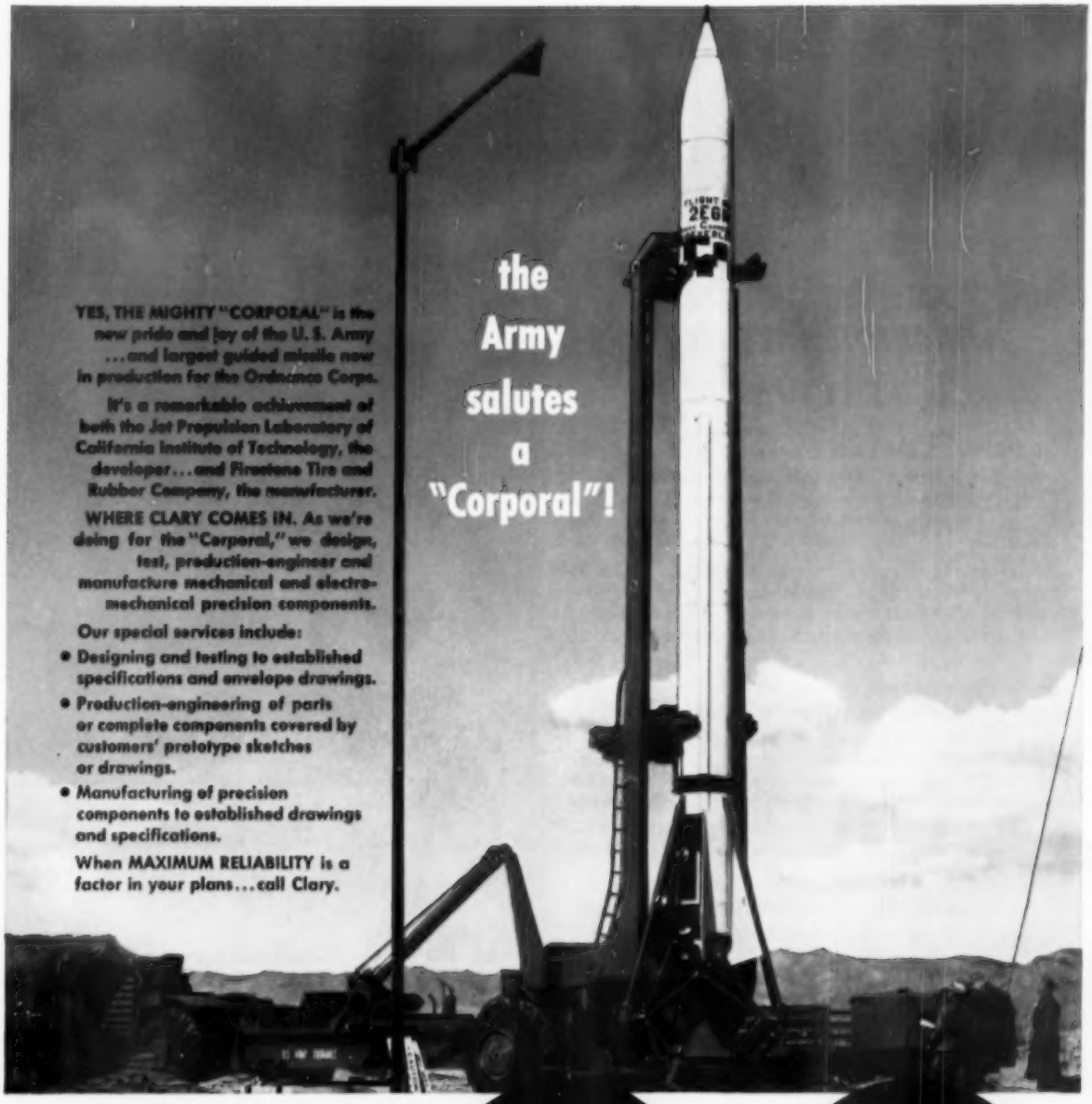

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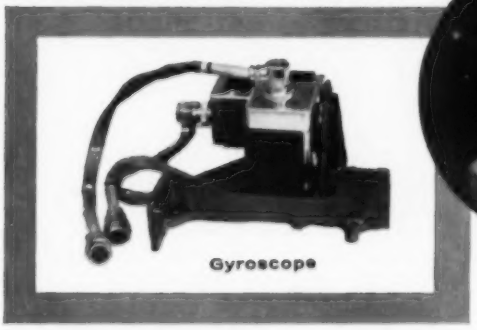

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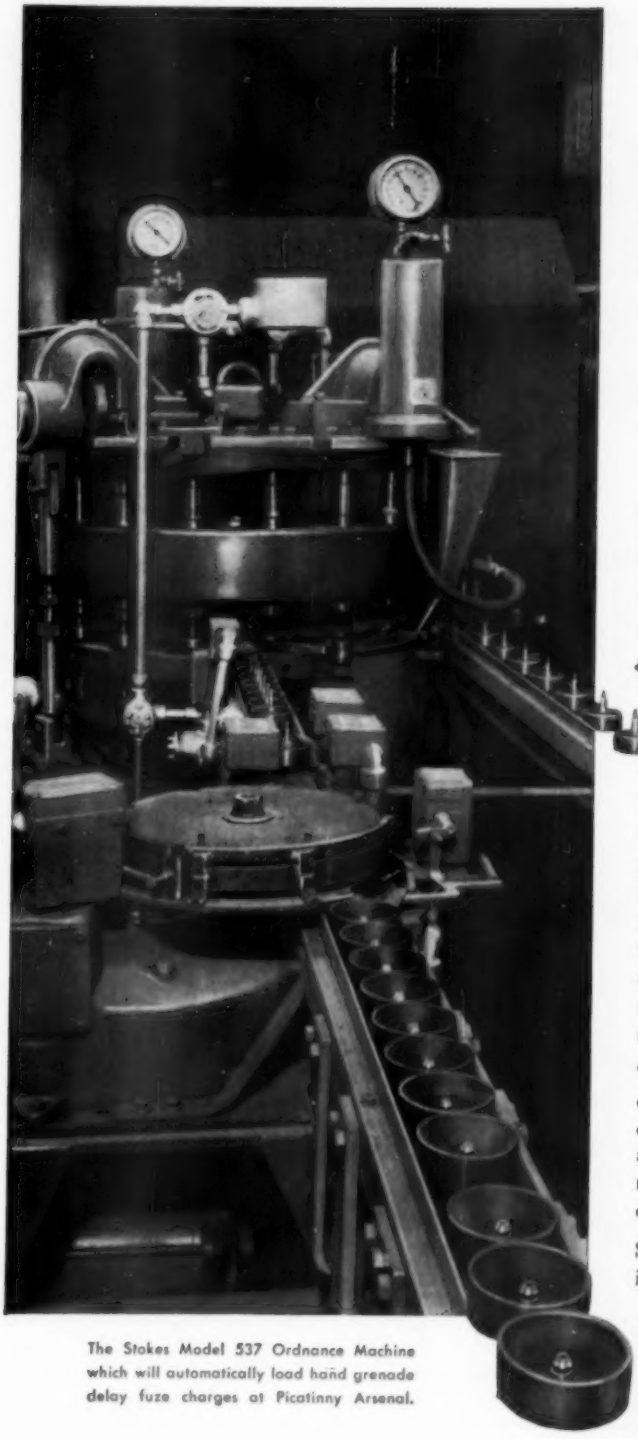

The Stokes Model 537 Ordnance Machine which will automatically load hand grenade delay fuze charges at Picatinny Arsenal.

Costs down...production up... operation safer... with STOKES automatic fuze-loading machines

Picatinny Arsenal, Dover, N. J., will replace a hand-fed fuze production line with an automatic Stokes loading machine. Loaded hand grenade delay fuzes will be produced up to 5 times faster than with the hand operation at substantially reduced cost. Following Picatinny's lead, other arsenals throughout the country will install similar machines. Operating in an isolated area with push-button control from safety stations, fully automatic Stokes equipment provides greatly increased safety of operation.

For this application, Stokes engineers developed a feed system and adapter which makes it possible to handle the irregularly shaped pieces automatically. Compacting of the charge is done in two stages for better consolidation. Height of charge is accurately checked at both points. Nine safety checks are made at critical points in the complete sequence of 15 automatic operations.

This machine, the Stokes Model 537, is designed for quick adaptation to the production of other components such as delay tubes, booster charges and other irregularly shaped pieces with only minor changes in the feeder, controls, safety checks and punch design.

Stokes Ordnance Division has 40 years' experience in designing equipment for automatic loading, inspection and other phases of ordnance production. This experienced counsel is at your service.

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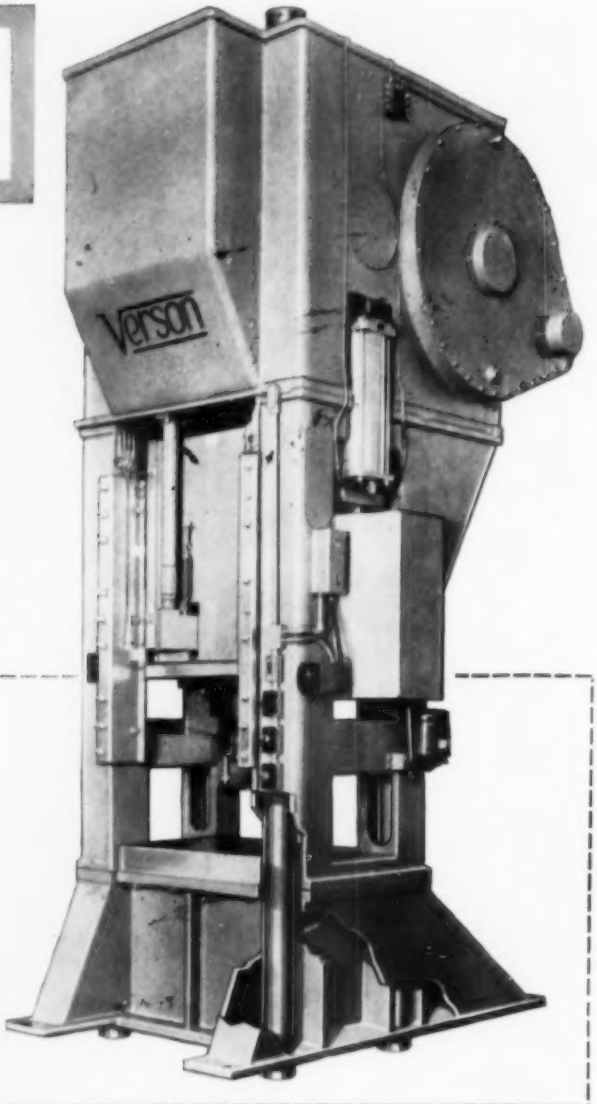

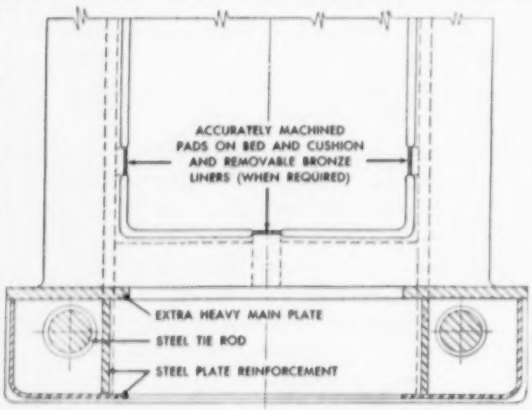
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setting the pace—in growth, quality and service

Better service for users of forgings

Kaiser Aluminum's recently-acquired Erie forging plant—one of the nation's three major aluminum forging plants—is now providing industry with a continuing supply of high quality aluminum forgings, plus nationwide service.

The Erie plant can produce aluminum die forgings from the smallest size up to 150 pounds as well as hand forgings up to 700 pounds, and has a rated capacity of 12 to 15 million pounds per year.

For years, Kaiser Aluminum has been a major supplier of aluminum in many forms. The acquisition of the Erie plant makes it possible for us to bring important benefits to users of forgings.

Sales service—The addition of aluminum forgings to our wide range of mill products enables our nationwide sales force to increase its service to our customers. Personal attention is given to every order from the time it is received until the forging is delivered to the customer.

Engineering service—We are increasing the present staff of experienced engineers. These men are highly skilled in die and forging design and are available for customer consultation.

Quality control—Trained laboratory technicians, using the most modern testing methods and equipment, assure highest quality forgings to meet rigid specifications.

Production control—The most modern methods of production control are employed to expedite material flow, die making, forging and finishing operations, thus insuring maintenance of shipping schedules.

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guarantee

performance . . .

Each of these insignia represents a unit world-famous for the most vital of military virtues — dependability. Military reputations are not easily won, and that is why the Olin Mathieson Chemical Corporation is so proud that its products, brands and branches have been on permanent duty with our Armed Forces since the days of the Sharps rifle. The complexities of national security and of the materials for defense have increased enormously since those days, but the basic requirement of dependability remains constant. Any of the insignia *below* can be called to duty today, with the knowledge and confidence that the varied products they represent have served the Armed Forces with distinction.

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More Air Force for America's Dollars with SIMULATORS

Air Force—Curtiss-Wright teamwork strengthens our defenses, cuts costs by millions. Officially reported in AMERICAN AVIATION Daily:

January 21, 1955 **American Aviation DAILY** Page 128

MATS REPORTS SUBSTANTIAL SAVINGS FROM USE OF SIMULATORS

West Palm Beach AFB, Fla. -- The Military Air Transport Service is saving more than $4,000,000 per year in pilot training costs at its training center here through the use of five Curtiss-Wright flight simulators, MATS officials have disclosed. The simulators involved include three of the Boeing C-97 type and two Douglas C-124 type units, each costing about $800,000.

MATS officials said that these five simulators represent the largest single concentration of multi-engine flight simulators in existence. Although the USAF has taken delivery of 115 of 174 electronic simulators ordered to date, a large percentage of these have been single-engine aircraft simulators.

The first simulator to be installed at the MATS base, which was reactivated in 1951, was a C-97 unit delivered in November 1952. Since then, MATS has accumulated more than 20,000 hours of training time on the C-W simulators and trained more than 1000 crews. During the entire period total down time due to maintenance, during which training could not be made or completed, was only 138 hours 5 minutes. Average training time per day for the five simulators has ranged from 10 hours on the lowest time C-97 simulator to 13 hours on the highest time C-124 unit.

Comparison Values Being Developed

For general comparison purposes, MATS considers that it costs $30 per hour to operate a four-engine aircraft simulator compared with $350-$400 per hour for the aircraft. As yet it has not been possible to say that a given number of flight simulator hours are the equivalent of so much actual flight time but some specific values are expected to be developed by next summer. At present MATS is using several different ratios to gain practical experience on relative merits of the two types of training. In these tests simulator time ranges from one hour per hour of actual flight time, to 20 hours aircraft time to 30 hours simulator time, to 15 hours aircraft time to 38 hours simulator time.

Curtiss-Wright is expected to deliver the first C-118 (Douglas DC-6A) simulator to MATS this summer. It is one of five types of simulators now making up approximately $8 million dollars in simulator backlog at C-W. The other types include simulators for the Lockheed C-121 (Super Constellations), Lockheed C-130, Convair's C-131 (240) and the Boeing RB-52.

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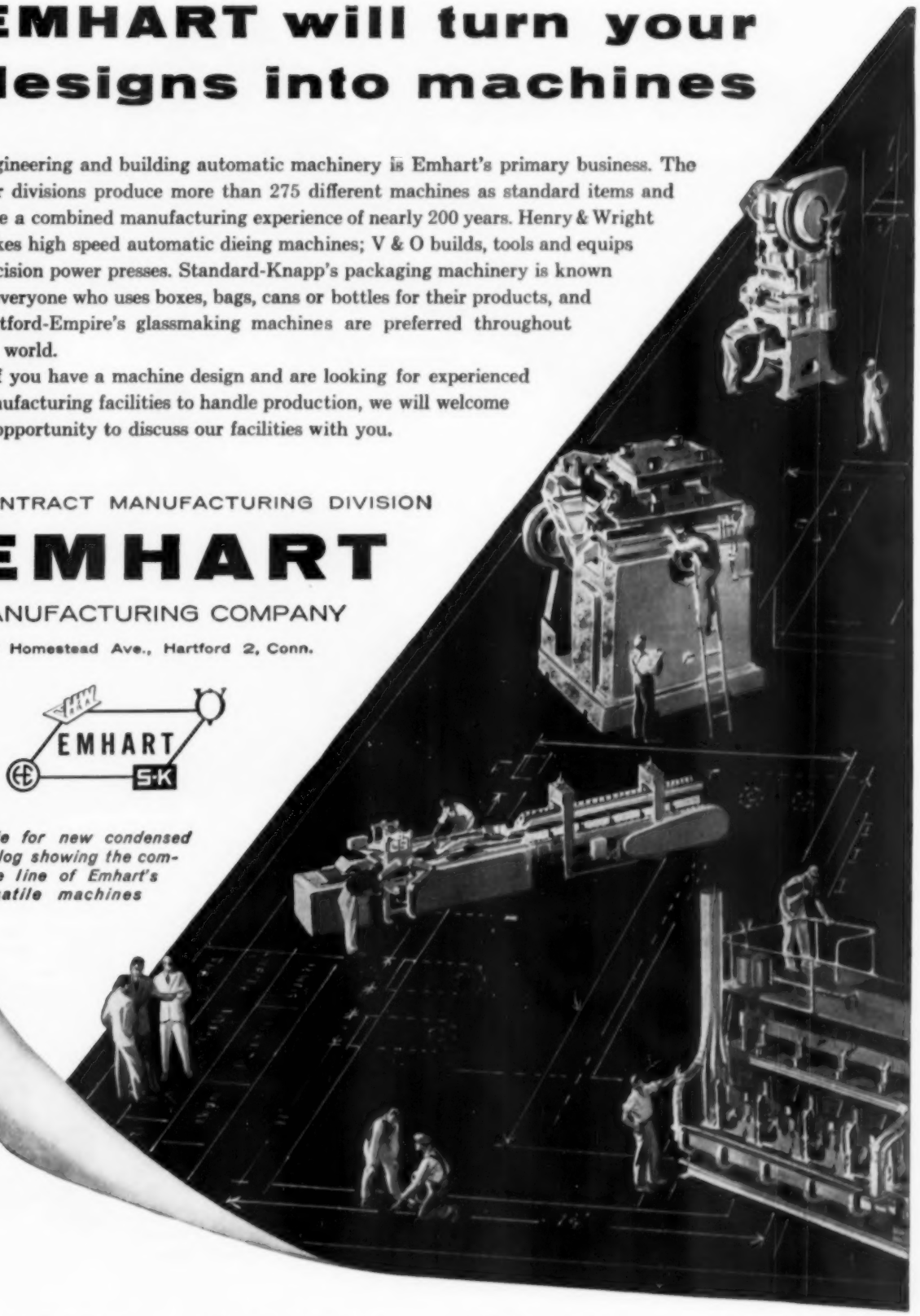

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Hoffman design and engineering ability, of the level that develops explosives clean-up and collection systems, is reflected in pneumatic applications of many kinds; in industrial filtration operations; in improved procedures for metal cleaning and pre-coating; in the solving of many production problems.

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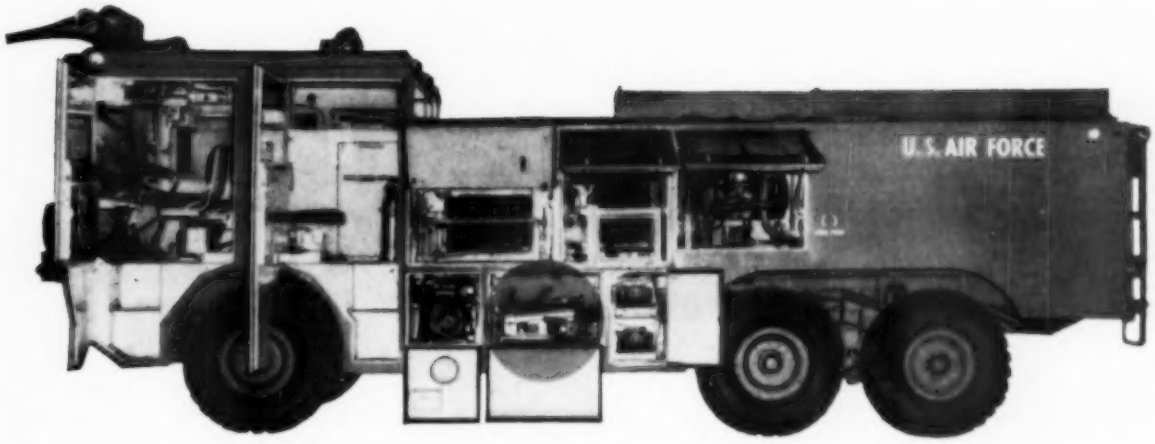

everything has to work...and it does!

Test personnel of the Air Proving Ground Command recently returned after more than 1000 hours of Operational Testing on the Type 0-11A USAF Crash Truck built by American-LaFrance-Foamite. A Janitrol 90,000 Btu/hr. Liquid Heater is standard equipment on this all-weather vehicle, and supplies all heating requirements.

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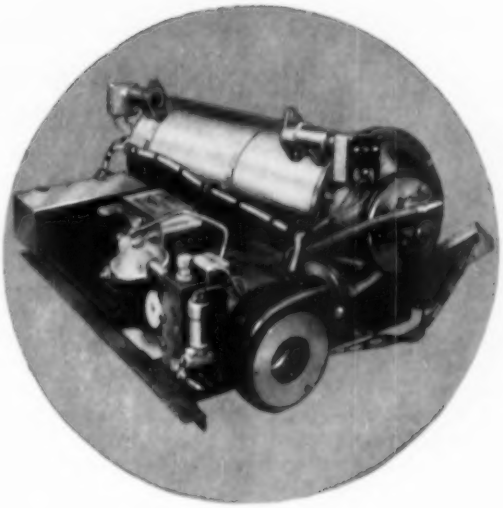

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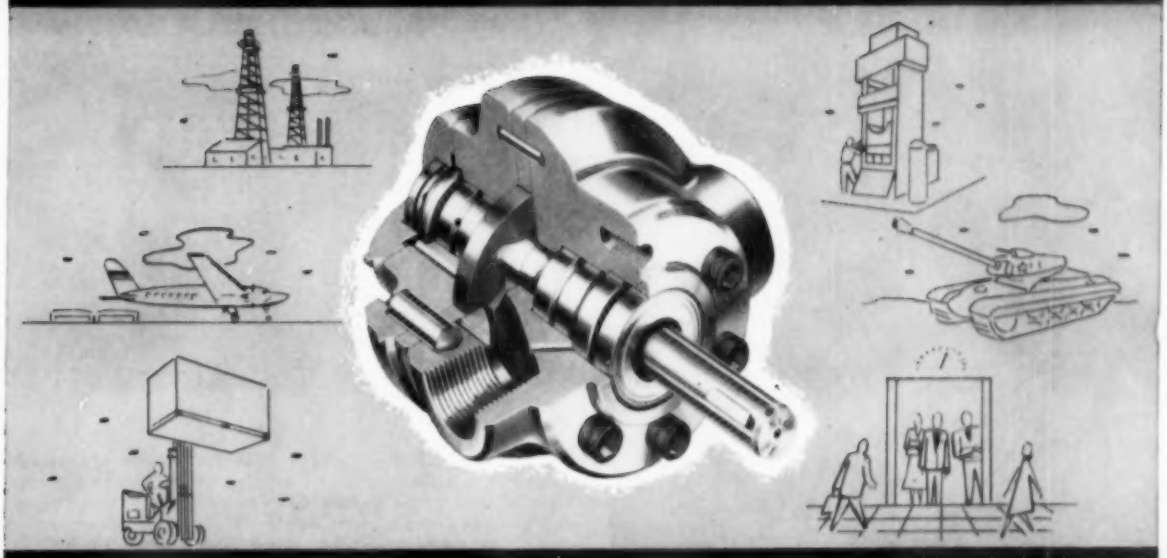

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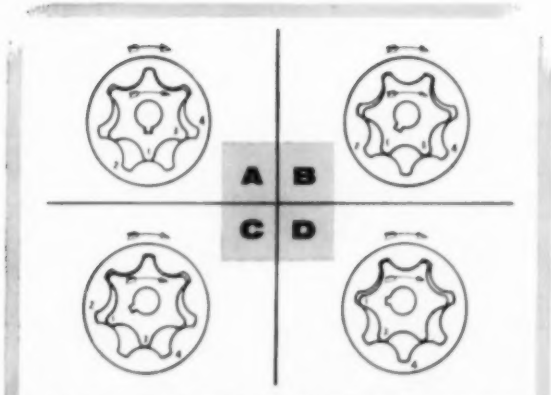

The two Gerotors revolve at different speeds, resulting in a continuous opening and closing of the spaces as shown in this diagram. Follow the changing position of tooth #1 as rotation takes place. Note its relation to space #2. As rotation continues, tooth #1 gradually displaces oil from space #2, thus creating pressure. The outer rotor of the Gerotor principle is designed with one tooth more than the inner rotor, with fluid-tight contact at all points. As a result, low tooth sliding velocity is achieved.

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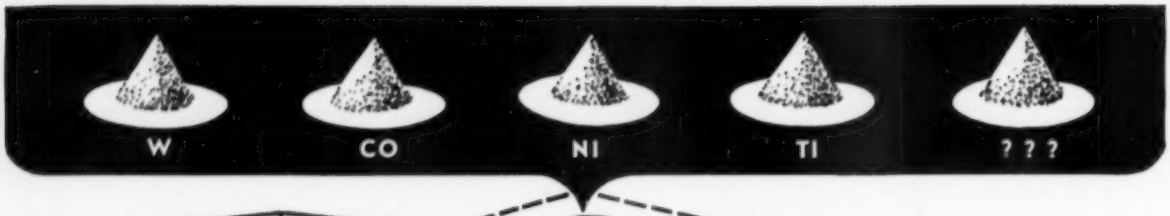

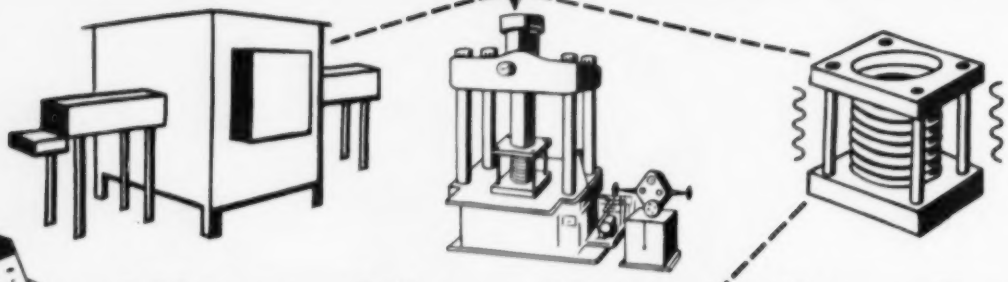

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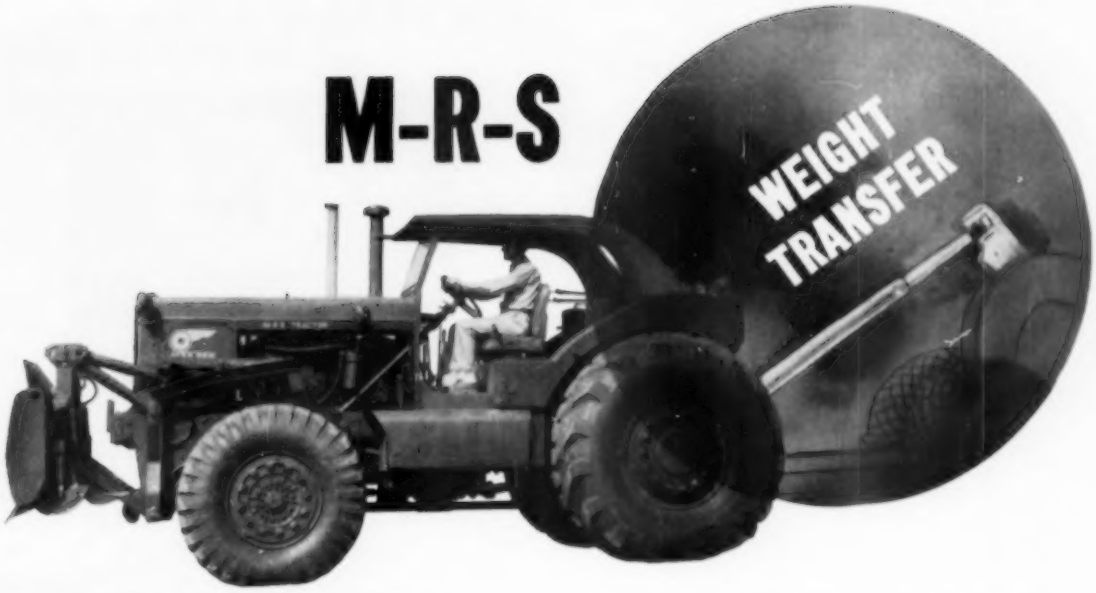

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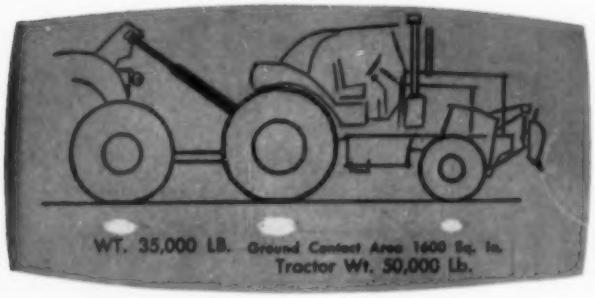

NORMAL HAULING POSITION . . .
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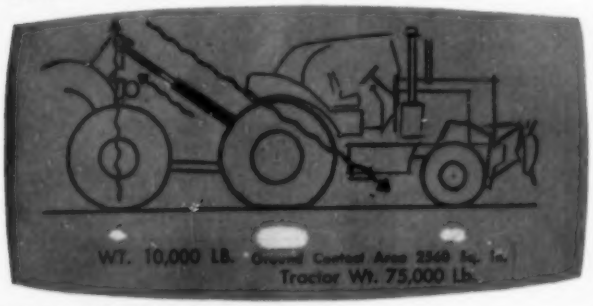

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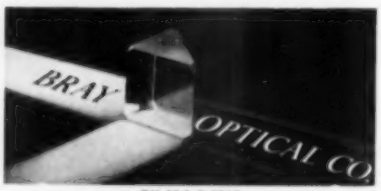

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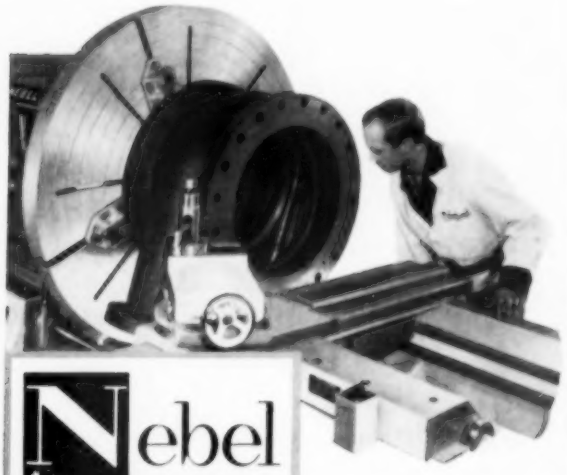

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ARMAMENT TECHNOLOGY

This section of ORDNANCE contains articles of a detailed and technical nature on ordnance research, development, manufacture, field use, and related subjects.

Rocket Launcher XM289

New truck-mounted equipment transports and fires the Honest John

Donald L. Meyers

Chief, Special Projects Section, Ordnance Weapons Command, Rock Island, Ill.

"GET thar fustest with the mostest" is a remark generally credited to that redoubtable gentleman of Civil War fame, Lieut. Gen. Nathan Bedford Forrest. This statement was particularly suitable to the type of warfare of that period (as he and his men amply demonstrated), and the truth of that particular concept has been proved by almost every battle or war of historical significance.

In the lexicon of today's armed forces the term "mostest" generally carries the implication of blitz blows delivered to the enemy as the result of a reservoir of previous technical application in the field of weapons research.

BASED upon these precepts, the design of the 762-mm. truck-mounted rocket launcher XM289, for the ground-to-ground rocket, "Honest John," exemplifies the most recent thinking along the lines of mobility, simplification, and the ability to strike with devastating effect.

It has followed lines that, although somewhat unconventional from a standpoint of previous artillery carriage design, represent sound engineering principles proved by rigorous engineering and field testing.

The launching beam of this weapon may be cited as a prime example of the above features. Simplicity in construction, with utmost rigidity for accurate launching, were the key characteristics applied to the development of this member. Painstaking calculation prescribed the triangular section with reënforced corner members and monocoque construction as the best design for this purpose. The material from which the beam is fabricated thus has been distributed in order to provide the best strength-weight ratio possible.

BASED upon experience relative to shortages of materials during previous emergency periods, this unit (and other structural members of this launcher), are made of plain carbon steel, which is one item that not only has a high availability index but lends itself to ready repair by field welding and other methods.

This launching beam is actually a weldment forty-four feet in length providing thirty feet of guidance for the rocket.

The use of a standard vehicle for the transporting unit is a design criterion which at first glance may seem to be of itself the simplest solution to this kind of problem. As a matter of fact this proves, almost invariably, not to be the case. Special considerations, such as traversing, elevation, or loading clearances

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Cecil C. Fawcett
Many advantages are claimed

Mounted on a 5-ton truck chassis, the 762-mm. rocket launcher is completely mobile and can be set up rapidly for firing.

for the launching device usually rule out standard carriers and call for the use of special vehicles, some of which, incidentally, are pretty grotesque.

Fortunately as development progressed, and with every effort expended toward the use of a production-type mobile platform, it was found possible to achieve a mounting on the 6-wheel-drive, 5-ton truck chassis M139D by means of extremely simply alterations, many of which can be made by field units.

This is a vehicle having ample power to negotiate the roughest kind of terrain that mobile weapons are called upon to traverse, with ability to perform "hit and git" tactics whenever needed.

ANOTHER case in point, in which the application of the simplicity feature is emphasized, is the design and construction of the five leveling-jack members. Irregular or sloping launching-site conditions dictate a requirement for 10-degree sidewise or 3-degree fore-and-aft leveling, while accuracy at all ranges calls for an absolutely stable and solid base for mounting the launcher. Speed of operation is also a factor which was not to be ignored.

The construction finally chosen overruled the apparent advantages of hydraulic jacks with their inherent high efficiency factor in favor of the more dependable telescoping screw-type mechanical design having a solid and permanent self-locking feature. Handwheel drives quickly lower the jack rams into sockets integral with the floats, which are first removed manually from their carrying positions on the fenders and placed on the ground under each jack for this operation.

Ratchets incorporated in the handwheel design are now brought into action by the simple rotation of a knob, and jack levers are inserted into sockets (also a part of the handwheel unit) for the actual operation of driving each jack ram to a point where the launcher is level in a crosswise direction with the tires no longer resting on the ground.

Stability and rigidity are achieved in this manner in a matter of a few minutes—a far cry from the "digging-in" procedure that might be expected with a mount of this magnitude.

Another blow for the case of simplicity is the treatment followed in development of the equilibrators. These are simply compression springs mounted in telescoping steel cases. Their movement is limited to the length of travel in which their effect is most useful (5 to 22 degrees' elevation).

The connection to the launching beam is an open-end affair allowing the equilibrators to part company from this member when fully extended during the elevation operation and when a need for their full counterbalancing force is no longer required.

Thus two relatively short compression struts do the work that could conceivably have required a considerably more complex design if the theoretically more desirable solution, calling for complete equilibration over the entire range of elevation, had been used.

ELEVATION of the piece has called forth a design effort resulting in a rather unique screw and linkage system. Power for elevation is obtained from the truck motor by means of a standard power take-off unit.

Directed by means of a torque shaft to a transmission unit located on the vertical pivot point ("pintle" to artillerymen) this rotation effort is carried upward to the center of the trunnion axis where it is transmitted by a bevel-gear arrangement to the elevating screw shaft which is affixed to, and lies parallel with, the bottom of the launching beam.

Elevation action is obtained by rotation of the elevating screw in a nut which is integral with a movable carriage forming a trunnion connection at the topmost end of the elevation "A" frame. This member also follows the monocoque construction pattern of the launching beam and for the same reasons—simplicity and rigidity.

As in all field weapons, a handwheel drive is also provided for the elevation operation. A lock-out device is used in connection with this to render the power drive inoperative during hand operation and also to eliminate handwheel spin during power actuation.

Elevation range for this launcher is from 5 to 60 degrees. The traverse range is from 15 degrees right of center to 15 degrees left of center. The drive for the traverse operation is the very essence of simplicity, consisting of a handwheel-driven torque shaft running forward from the top carriage to a more or less conventional speed-reducing unit, upon the output end of which is a spur pinion which engages the traversing gear sector attached to the traverse beam, the ends of which form the lower pivotal members for the elevation "A" frame.

SOMEWHAT less conventional is the relation between the traversing platform, which is a flat box structure supported by the central part of the truck chassis, and the traverse beam mentioned above. The traverse movement between these units is effected on a "king size" roller raceway which is lifted slightly out of engagement during road use of the launcher in order to avoid the brinnelling effects of the rollers.

The traverse platform also serves as a structure supporting the control jack housings, which are mounted at either end.

In order to decrease sway while traveling and to remove unnecessary load from the elevating mechanism, a travel lock was developed which attaches to the front bumper of the vehicle. Connection with the launching beam upon "march order" consists of manually pivoting the travel lock frame upward into position, lowering the beam into it, and by means of hand-operated, screw-driven clamping jaws, making an attachment to a slide on the lower portion of the launching beam.

An electrical interlock system has been provided to prevent overtravel of the elevating mechanism in either direction, to prevent power actuation of this mechanism when the elevation handwheels are engaged, and to prevent engagement of the power take-off unit with an accompanying power elevation action to the launching beam during periods of road travel.

Also, since the Honest John rocket used with this launcher requires the use, at some temperatures, of an electrically heated blanket, similar in many respects to those providing sleeping comfort to individuals, an engine generator set, housed in a closure capable of watertight sealing for deep fording requirements, has been mounted on the right rear operator's platform.

For safety reasons, power for firing the rocket is derived from an outside source.

A standard M62 five-ton wrecking truck is used as the reloading vehicle, lifting a rocket from a pole-type trailer XM329 to the mounted position on the launching rail as a standardized operation and in a minimum of time. Normally, however, the launcher will travel to its launching site fully loaded and capable of going into action very quickly.

BUT, best of all, from the standpoint of the field personnel manning this launcher, is the method by which aiming is accomplished. Here, again, simplification is evident since the same methods of laying are used that are common with gun carriages such as the 155-mm. The same gunnery training can be put to use as artillery crews have used in the past. No new techniques are required.

The ground-to-ground Honest John rocket rests on the XM289 launcher in firing position at 30 degrees' elevation.

Armament Technology

Guided Missile Training

Within four years the Ordnance Guided Missile School has grown from experimental beginnings to take an important part in the maintenance and testing of our newest weapons

1st Lieut. Edwin F. Trout

IT'S too early to tell if push-button warfare is just around the corner—but if it ever comes, guided missiles will be the backbone of it. War has come a long way since the Boys in Blue charged across Virginia farms, or doughboys dug trenches in Flanders.

In fields such as missiles, the complexity of war has reached almost staggering dimensions. Not only does the operation of this equipment require careful preparation and training but so do the maintenance and repair.

Army Ordnance began planning early to meet its training responsibilities in the new field of missiles. In June 1951 the Ordnance Training Command at Aberdeen Proving Ground established the Guided Missile Branch of the Ordnance School. This new branch, in time, was to develop into the present Ordnance Guided Missile School now located at Redstone Arsenal, Huntsville, Ala.

THE scope of the branch's mission was broad indeed: to plan and develop all phases of guided missile training for the Ordnance Corps. This included preparing the required programs of instruction for the courses to be offered student personnel, purchasing the necessary equipment for training, and obtaining a nucleus of administrative and instructor personnel. All were essential to a branch whose sole purpose was to "teach guided missiles."

The armed services had been studying guided missiles since the late stages of World War II, and a number of new missiles were already in the research and development stage at this time. The Antiaircraft Branch of the Artillery School, Fort Bliss, Tex., had been redesignated the Antiaircraft and Guided Missile Branch and had initiated limited training for personnel of all the services in addition to assisting in research and development activities.

Lieutenant Trout is assigned to the Ordnance Guided Missile School, Redstone Arsenal, Huntsville, Ala.

However, the types of units which were to employ missiles as weapons and the maintenance and support units needed to reënforce the users had not progressed beyond the point of verbal discussion. In fact, the intricacies of the weapons themselves were largely unknown.

To centralize and accelerate this planning, the Guided Missile Branch was transferred to headquarters of the Ordnance Training Command in July 1951 and became a staff division of that headquarters.

As viewed by many, the new Guided Missile Division was still premature. However, it was conceded by all that if the guided missile was to achieve operational status in less time than is usual for an entirely new type of weapon, all phases of development, including training, would have to be telescoped.

Each stage of the program would have to be initiated before completion of the preceding one.

The infant Guided Missile Division originally consisted of 20 men including 10 officers, 5 enlisted men, and 5 civilians. Five had obtained some previous experience in the missile field; the rest were chosen from the ranks of men working with integrated fire-control systems. Obviously, the division's first task was to teach itself just what guided missiles were.

THE problems encountered in screening persons for the new division made it apparent that the Ordnance Corps' need for guided-missile training had developed at a most inopportune time. The Corps had just gotten into the swing of training men for light aircraft and integrated fire-control maintenance.

Requirements for these two programs had already provided a home for most Ordnance people interested in, and capable of, teaching the subjects required to understand the intricacies of a missile system, and neither of the programs had been in existence long enough to produce a pool of men who could be readily cross-trained in the new field.

All planning in the new division had to be predicated on teaching personnel without prior military training or "retreading" Ordnance personnel with little background or native interest in

the important field of electronics maintenance.

AFTER training its own small staff, the Guided Missile Division set out to prepare a program that would: (1) Determine the prerequisites of personnel required to service missile systems, obtain the necessary military occupational specialties, and establish them in a permanent career field; and (2) Prepare programs of instruction to support the new military occupational specialties and secure qualified instruction, facilities, publications, and training equipment to implement the new courses.

Determining the type and caliber of maintenance personnel required to support a missile system posed quite a problem. The system is composed of a missile which, in essence, is a rocket with an electronic control system in lieu of a pilot and a ground guidance station composed of various combinations of radars, computers, and a central control center.

Many additional items are needed to maintain the system and handle the missile prior to launching. The mechanical components of a typical system are very similar to those used in modern piloted aircraft.

Therefore, it appeared quite feasible to establish a training course for repairmen who would service the mechanical portion of the missile and similar components found on the transporting vehicles and handling equipment.

The electronics of the missile and the ground guidance station posed a more formidable problem. Individual parts and subassemblies were complex in themselves, while an entire system became a near nightmare.

It was deemed wise to establish two levels of electronic maintenance: a first level or "helper service" to assist in general electronics repair, and a second level of specialists highly trained in specific portions of a system.

The helper level course is for the electronics guidance components' repairman. His duties are to assist in the service of all individual electronic parts found in either the missile or the ground guidance station.

THE design of the system suggested that the specialist courses could be divided into two areas: the internal guidance system repairman, who services the complete electronic system of a missile as a whole and all related test equipment, and the external guidance system repairman, who services the complete electronic system of a ground guidance station as a whole and all related test equipment.

A separate guided missile officer course was also considered desirable because this new Ordnance item was both complex and dissimilar to other weapons then in the field. The course was designed to provide an all-inclusive technical knowledge of the complete missile system in addition to the receipt, storage, and issue of missile material.

NECESSITY dictated that all initial schooling provide a broad theoretical knowledge of the principles upon which a guided missile system are built, because any of the basic systems were sure to undergo many changes before they became fully operational. In some instances, satisfactory design of a particular component was still being sought.

This led the Guided Missile Division to undertake comprehensive study of the SCR 584 radar, the T33 radar, aircraft maintenance techniques, and principles of autopilots on the assumption that, while a system might become more complex, it would still employ principles long used in these proven pieces of equipment.

As a result, the first courses offered were to include calculus, differential equations, LaPlace transforms, supersonic aërodynamics, high-frequency

Trainees at the Guided Missile School learn the technique of fighting propellant and explosives fires.

Armament Technology

Officer students assigned to the school are thoroughly trained in the operation and maintenance of test equipment used in guided-missile development.

electronics, radar, and thermodynamics.

At this point the division was divided into several groups. One group had the sole responsibility of developing preliminary drafts of programs of instruction for the separate courses. The remaining groups drew up lists of equipment, facilities, personnel, funds, and training aids required to support the courses.

THE "nearest like items" of existing military equipment such as the T33 radar, autopilots, gyroscopes, and aircraft were used as guide lines to form these lists and preliminary programs of instructions.

The tentative tables of organization and equipment, the time required to train a man, and the number of men to be trained soon made it apparent that in event of full mobilization the demand for guided-missile technicians would far outstrip the facilities for training that would be available at Aberdeen. An adequate and permanent home for the school had to be found!

Complete evaluation of available facilities ultimately ended in the selection of Redstone Arsenal, near Huntsville, Ala., as the site. The arsenal had already been reactivated and assigned the mission of guided-missile and rocket development for the Army, and its huge area allowed the proposed school almost unlimited room for expansion.

Had you visited the Guided Missile Division at Aberdeen Proving Ground at this time, you would have noticed two recent additions. A new planning group was drawing preliminary plans for the school's training shops, classroom and laboratory buildings, troop-housing area, supporting shops, and other necessary facilities.

Meanwhile, a second new group was letting contracts to civilian concerns experienced in electronics and aircraft maintenance for their services in training a key cadre for the new school. The professionally trained cadre would form the original instructor staff.

In February 1952, part of the division moved from Aberdeen to Redstone Arsenal to secure temporary buildings, office equipment, and troop housing. The rest followed in March, and, on the 3rd of the same month, General Order Number 5, headquarters, Redstone Arsenal, designated the new organization as the Provisional Redstone Ordnance School.

One week later the first class in the Guided Missile Officers' Course was begun in a converted ammunition manufacturing building. Seven officers attended, and equipment consisted of standard college textbooks, military publications on electronics, and a few pieces of test equipment that were personal property of the contract civilians employed as instructors. Equipment originally procured for this purpose had not been received from Aberdeen Proving Ground.

Two enlisted men's courses were started during April 1952: the Mechanical Systems Repair Course and Phase II of the Electronics Guidance Components Repair Course.

The latter was a 6-week course, supplementary to the basic electronic training given at the Signal School, Fort Monmouth, N. J., and was designed to familiarize a student with missile systems after he had learned fundamental electronics.

BY the end of July, the school had built up skeleton laboratory setups of standard electronic test equipment. Specific missile equipment was still lacking, but substitute items like SCR 584 and T33 radar sets for the external guidance systems course, and autopilots, gyroscopes, German V1 and V2 guidance units for the internal guidance systems course had been secured.

Salvaged parts from V2 and prototype American missiles dropped by various research and development agencies were also on hand for the mechanical course. For the next six months this was the only equipment available for student laboratory exercises, but, seasoned with ingenuity and imagination, it served quite admirably.

However, several of the courses temporarily had to be reduced in length, and the bulk of instruction was presented via the blackboard.

During 1952 the school was confronted with other interesting problems. First, it was located in a group of old ammunition manufacturing buildings and World War II barracks. These had been abandoned after the war and never maintained. Yeomanlike service from the troops themselves and the Post engineers provided light, heat, power, building repairs, and badly needed paint. But in spite of work through the Christmas holidays, all the buildings were not heated by January 1953. All concerned were thankful for Alabama's relatively mild winters.

SINCE the school was still a provisional organization, funds slated for new construction during fiscal year 1952 and 1953 were not realized. Technical information on missile projects was slow in filtering down to the school, and qualified civilian personnel, who could have compensated for the dearth of literature, were very hard to find.

Student inputs were erratic, the individuals sent for training didn't always

meet the established prerequisites, and many of the badly needed technical personnel had to be assigned to administrative and housekeeping duties. In spite of it all, morale was surprisingly high, probably due to the sense of satisfaction in breaking ground in an exciting field.

A joint Ordnance-Signal training agreement moved Phase II of the Electronic Guidance Components Course to the Signal School, Fort Monmouth, between October and November 1952 and provided a Signal detachment, the 9615th Technical Service Unit, of fifty-one men to the Provisional School to assist in the instruction of the electronic portions of the courses offered at Redstone. This "shot in the arm" alleviated the instructor problem for some time.

Another boost came early in 1953 when the key-cadre schools at both White Sands Proving Ground and in contractors' plants in Los Angeles were closed. In addition to the instructor personnel, all the equipment used by these schools was assigned to the school at Redstone and the allied school at Fort Bliss, Tex.

ON February 16, 1953, a Department of the Army Order designated the school at Redstone as a Class II activity under the jurisdiction of the Chief of Ordnance and changed the name to the Ordnance Guided Missile School, a Department of the Army specialists' school. This was a tremendous lift for morale.

But of far more importance, the problems of supply, funds, troop housing, and training facilities now fell into normal channels, and the processing of school requirements was far more rapid than it had been under the provisional status.

From then on guided-missile equipment, training aids, interim publications, tools, test equipment, and repair parts literally flowed into the courses of instruction. Work continued on the renovation of temporary facilities, and plans were completed for a new course —the Guided Missile Propellant-Explosive Specialist's Course.

Ordnance had previously been assigned responsibility for receipt, storage, maintenance, and issue of guided-missile fuels and explosive components. This was deemed too hazardous and extensive a mission merely to be added to the scope of ammunition-handling courses in existence, nor would all potential ammunition handlers have to be acquainted with the eccentricities of volatile missile propellants.

CONSEQUENTLY, the new course was then established for selected students who could better satisfy the needs of the field as fuel and explosives specialists.

Meanwhile, the quantity of technical data being integrated into each of the other courses and the amount of equipment that had to be learned by a student made it desirable to divide the initial Military Occupational Specialty Specifications into smaller areas to reduce the enormous amount of material each potential specialist was being asked to digest and absorb. The Department of the Army also hoped to obtain one full year of service from a 2-year draftee, thus training of less than one year was a necessity.

These two problems led the Office of the Chief of Ordnance to begin the Ordnance-Signal joint study for the improvement of Ordnance guided-missile training. Several conferences later, and after a considerable amount of pick-and-shovel work at all training levels, the committee's final report recommended the establishment of the courses now being taught at the Ordnance Guided Missile School.

These courses cover the same material as previously, but emphasize practical work with the actual missile system under study. The new courses have eliminated the "nice-to-know" material and the theoretical subjects as much as possible. This has, of course, increased the graduate's ability to maintain and service the equipment and has definitely increased the amount of time each specialist is available for field work.

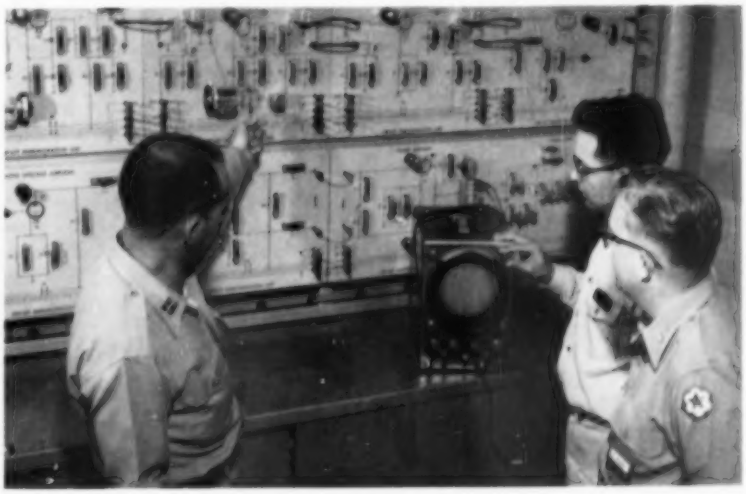
In August 1953, the school was placed under the command of the Ordnance Training Command at Aberdeen Proving Ground with Redstone Arsenal responsible for the administrative and logistical support and military discipline.

EARLY 1954 found the Ordnance Guided Missile School in comparatively good condition. The first of the new buildings was finished and occupied in April—a 360-man barracks with mess facilities. Necessary training equipment was on hand, with minor exceptions.

The temporary buildings were in a very respectable state of renovation, considering their past history, and the school was momentarily over its authorized strength.

A visitor to the Ordnance Guided Missile School today will find a thoroughly qualified instructor staff utilizing the talents of persons from many walks of life, adequate equipment, and a high state of morale. New buildings will soon be finished and "OGMS," as it is commonly called, is now concentrating on efficient management, liaison, and future planning.

A basic demonstrator with printed circuits is used in the early stages of electronic instruction at the Redstone Guided Missile School.



Armament Technology

Welded Rotating Bands

The technique of depositing overlays on projectiles by the inert-gas-shielded metal-arc welding process has proved very satisfactory for thin-walled shells and also has many advantages for other types

Cecil C. Fawcett

THE Pitman-Dunn Laboratories of Frankford Arsenal have conceived and developed a new method of applying rotating bands to projectiles. The bands are derived from welded overlays deposited circumferentially on the projectile by the inert-gas-shielded metal-arc (consumable-electrode) welding process.

This adaptation of conventional welding, known as the welded overlay rotating band process, has favorably approached the advanced stages of controlled procedures and ballistic study. Its many advantages provide real competition for other types of bands, including the conventional variety and those now under investigation.

A rotating band fulfills two and sometimes three requirements for promoting satisfactory performance of the projectile, depending upon the type of ammunition. For all ammunition, the band serves as an obturator following ignition of the propellant and aids in the build-up of pressure for propulsion.

THE band also engages the rifling of the gun barrel and is thereby engraved to impart spin to the projectile for stability along its trajectory. An exception is the band of the recoilless-rifle projectile which is preengraved during manufacture.

Finally, in separated ammunition and in separate-loading ammunition (where the propelling charge and projectile are separate units) the band fixes the forward position of the projectile when it is rammed "home" before firing.

Mr. Fawcett is director of the Pitman-Dunn Laboratories, Frankford Arsenal, Philadelphia, Pa.

The conventional method of banding is the swaging of an annealed and pickled ring (band blank), usually copper or gilding metal, into an undercut and knurled band seat. This provides a mechanical interlock between the band and the projectile.

The welded overlay rotating band, however, becomes an integral part of the projectile because of the fusion bond. This entirely eliminates the possibility of the band becoming loose or separating from the projectile during its flight.

The idea of a welded overlay rotating band presented itself during experiments with the attachment of windshields to 120-mm. armor-piercing shot (solid projectiles). Difficulties associated with tack-welding by conventional metal-arc welding processes led to a trial of the inert-gas-shielded metal-arc (consumable-electrode) welding process.

The quality of the welding beads and the ease of applying them to the shot body suggested the possibility that a single bead or several overlapping adjacent beads could be machined into a rotating band.

The feasibility of banding by welding was first demonstrated by comparing this method with the conventional method on some scrap shot (see page 175). Welded overlays were applied by depositing a continuous bead in a closed spiral pattern, otherwise known as spiral indexing on the rear bourrelet. An overlay machined to the standard band contour is shown in this same illustration as well as some of the steps required to produce a rotating band for this projectile by the conventional process.

THE reliability of welded overlay rotating bands under firing conditions was first demonstrated with a medium-caliber recoilless-rifle shell. Overlay bands of copper, silicon bronze, aluminum bronze, and iron performed normally.

Very severe firing tests also were conducted with some small-caliber projectiles equipped with nonferrous overlay bands. These bands were not preengraved. The firings were all successful, and the bands on the recovered shells were intact with no signs of fragmentation or separation.

With this initial demonstration of feasibility and reliability, support was obtained for a program of research and development to adapt the welded overlay method of banding to many projectiles, among which the 105-mm. M1 shell held an early priority.

The development of welded overlay

Armament Technology

rotating bands has centered around one welding process. This is the inert-gas-shielded metal-arc (consumable-electrode) process which is generally known by such proprietary names as "Aircomatic" (Air Reduction Company), "Sigma" (Linde Air Products Company), and "Fillerarc" (General Electric Company).

THERE has been, however, an initial evaluation of the submerged-arc process for applying soft-iron overlays. The submerged-arc overlays were softer than any which have been deposited by the other process.

The inert-gas metal-arc welding process employs a bare wire electrode which is continuously fed and consumed. No flux is used. An inert gas flows through an orifice or nozzle surrounding the electrode and acts as a shield for the arc and puddle.

It has been found advisable to feed a nonelectrode or "cold" wire continuously into the arc and weld puddle in order to reduce penetration and pickup. This procedure also provides a means of injecting alloying elements and greatly reduces the time required for overlaying.

The rotating band on artillery projectiles is usually wider than a weld bead deposited in a single revolution. Therefore, a continuous and overlapping bead was deposited in two or more revolutions either by spiraling or by step indexing.

The spiraling technique was employed for only a short time because of the extra metal required at each end of the spiral. The indexing procedure was more economical but also has been superseded by the weave bead technique.

Overlays deposited by the two latter techniques are illustrated on page 174. The weave bead technique also greatly reduces the cost of equipment since it is cheaper to oscillate the welding head than to provide mechanisms for index or spiral feeds.

It has frequently been necessary to cool the projectile during the welding operation. This has been done in order to preserve the mechanical properties of projectiles as well as to prevent burning through the thin-walled varieties of shells. The cooling of the shells (hollow projectiles) is readily accomplished by injecting either air or water into the shell cavity while welding.

The welded overlay rotating band program was initially devoted to the development of an iron band for the forged, heat-treated, 105-mm. shell. This objective was given priority because of the production schedule for the projectile and the apparent need for conserving copper.

The hardness of the first iron bands overlayed on 105-mm. shells was approximately Rockwell B 85 to 90. These bands, which had the conventional contour for this projectile, produced high engraving pressures during laboratory tests. It was established that a softer weld deposit was required and that the rotating band should be redesigned to satisfy the new material and process.

DURING the subsequent months, welding procedures were gradually improved, and techniques were developed to anneal the overlay. It was found that the overlay could be softened by induction heating without appreciably lowering the mechanical properties of the shell steel. The anneal, however, did modify the heat-treated structure of the steel beneath the band area in a manner dependent on the thermal gradient imposed.

Although heat treating the shell after welding was believed to be a more logical approach, this procedure was not employed since the shells ordered for this work were all heat-treated and finish-machined prior to delivery. Through refinements in welding and by annealing the overlay it was possible to fabricate an overlay band having a hardness of Rockwell B 68 to 72.

In redesigning the band for welded iron, several band contours were evaluated. These contours deviated from the swaged gilding metal band design in that they contained cannelures or relief grooves.

TWO firing programs were conducted to ascertain the relative merits of each design. It was found that no significant difference existed between the performance of the test rounds and those containing the conventional band.

The band pressures showed small differences between the two materials, with those of the iron bands being equal to or lower than the gilding metal band pressures. Varying the number of cannelures from two to three produced no significant change in the performance of the test rounds.

The investigation of iron for the 105-mm. shell continued with an extensive firing program to determine the influence of the band material on the life of the gun tube. Five thousand rounds with welded iron overlay bands were fired along with an equivalent number of standard rounds.

The iron bands fabricated for the

The welded overlay technique has been successfully used to apply rotating bands to a variety of shell sizes.

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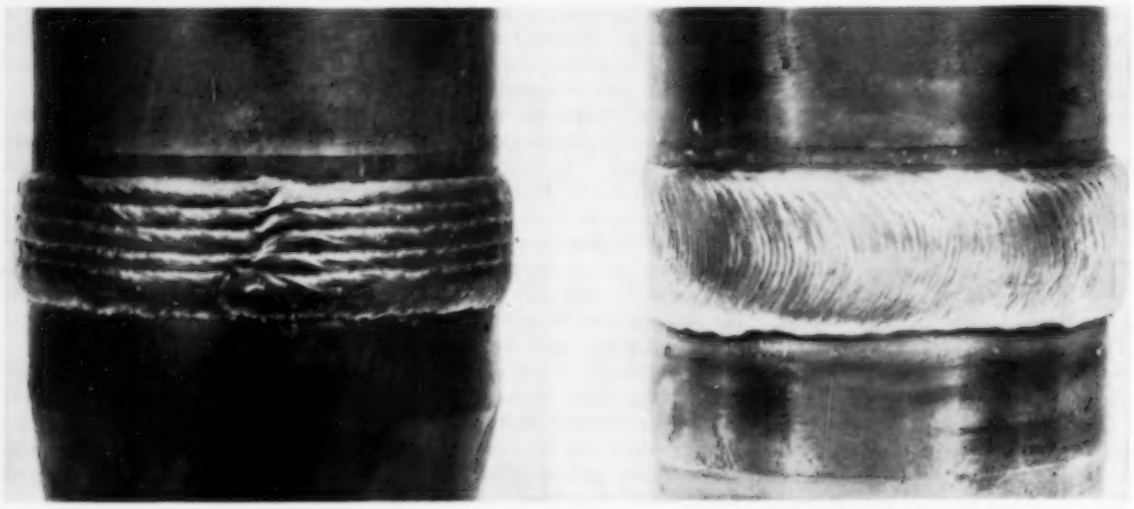


Comparison of overlays deposited by the step indexing technique, at left, and the more recent weave bead method, right.

test had a Rockwell B hardness of approximately 70 to 72 and were machined to conform with a 2-cannelure design selected from the preceding studies.

At a later date, other investigators conducted a similar but independent test during the course of a program on swaged sintered iron bands. The conventional band contour of the 105-mm. shell was retained for these rounds in that no cannelures were incorporated in the design.

Three new and modified M2A1 howitzer gun tubes were used for all these wear tests. The tube modifications included an increased depth of rifling and a change in the forcing-cone angle. These changes were service requirements and were in no way related to the wear tests.

AFTER firing 5,000 rounds with welded iron bands, the wear of the tube was slightly greater but similar in pattern to that which occurred in the tube used for standard rounds. The tube in which rounds with sintered iron bands were fired experienced the highest rate of wear. There was indication that some build-up of gilding metal from the standard band occurred in its tube between forty and eighty inches from the breech face.

Although the wear caused by welded iron was not considered excessive at this point, it was deemed advisable to continue the test to include 10,000 rounds. An additional 5,000 overlay banded shells were fired along with 5,000 standard shells, using the gun tubes under conditions that prevailed during the preceding test. Unlike the previous bands, however, these bands were painted along with the shell bodies.

Those concerned with the development of sintered iron, however, elected to adopt a 2-cannelure design similar to that of the welded band and initiated an entirely new test of 10,000 rounds.

The results of the second phase of the welded-band test were not as favorable as had been anticipated. The rate of wear increased sharply in the region of the forcing cone, approximately twenty-four inches from the breech face. Because of the extreme change in the trend at this point, it has been suspected that the paint on the band may have accelerated the rate of wear of the tube by chemical activity. However, the welded iron caused less wear throughout the tube than did sintered iron and more nearly approached that of gilding metal except for the immediate region of the cone.

There is no doubt that the welded iron bands, as they were prepared for these tests, were considerably more abrasive than gilding metal; however, the report of the proving ground stated that the wear experienced from the welded iron did not affect in any apparent manner the accuracy of these rounds.

The Pitman-Dunn Laboratories believe that peak performance has not been obtained with welded iron bands. The use of an AC series arc with an emissive coated electrode and an aluminum-coated cold wire provided an overlay appreciably softer than any which have been fired. This improvement could readily ease gun wear.

A FRAGMENTATION test conducted at Picatinny Arsenal utilizing several 105-mm. shells with annealed welded iron bands was incidental but none the less interesting. It was reported that visual examination of the fragments revealed that the welded iron band adhered to the shell wall and did not fly off separately as is experienced with conventional gilding-metal bands.

No other differentiating features were noted. The fusion bond of the welded band has been considered a definite advantage throughout this program.

There has been a great demand in the past year to develop copper and copper-alloy welded overlay bands. In applying overlays of copper, a gas shield of pure argon often suffices, but the addition of somewhat less than one per cent oxygen has been used to advantage to provide a more stable arc and a more uniform bead. The application of single beads with indexing has proved to be unsatisfactory.

The high heat conductivity of beads previously applied, compared with the conductivity of the steel projectile, greatly affects the welding conditions for subsequent passes. Higher currents

Armament Technology

are required and greater penetration is hard to avoid. The hardness will vary from initial to subsequent beads. The width is best achieved, therefore, by oscillating the welding head.

There is considerable industrial application of welded copper overlays for rotating bands. The filler metal has been limited to a proprietary silicon deoxidized copper which contains small amounts of tin and manganese. Its copper content is at least ninety-eight per cent.

Other commercially available deoxidized copper wires have proved unsatisfactory as electrode material but have been used, in an emergency, as cold wires. The development of copper and copper alloy filler metals has been initiated.

Satisfactory rotating bands have been made with overlays of aluminum and silicon bronzes. Silicon bronze (three per cent silicon) has performed satisfactorily in the as-welded condition. It is not suitable, however, if heat treating is to be done subsequent to welding.

Procedures have been developed for applying welded bands of the same composition as the conventional swaged gilding-metal (ninety per cent copper, ten per cent zinc) band. A copper-zinc welding electrode would lose most of its zinc by vaporization in the extremely hot welding arc. It has been necessary, therefore, to use a copper electrode, along with an eighty per cent copper, twenty per cent zinc alloy cold wire. The use of this combination of electrode and cold wire provides an overlay with the composition of gilding metal.

In overlaying copper and copper alloys, it is important to obtain a shallow weld bond with as little penetration as possible. Iron has a rather potent hardening effect on the copper alloy and should be limited, in most instances, to 1.5 per cent.

One of the main difficulties with a new production installation is the tendency toward excessive penetration and iron pickup in welded bands of copper. It is believed, however, that overlays for preëngraved bands may safely contain more iron since these bands do not undergo full engraving from the rifling when fired.

In June 1953 the production schedules of several 105-mm. shell producers within the Birmingham Ordnance District were threatened by a shortage of band blanks. The district and its contractors were interested in the welded overlay rotating band process and considered immediate conversion as a relief measure.

Iron could not then be recommended for the band because of its questionable effect on the life of the gun tube. Although copper or one of its alloys seemed suitable for this application, there was no information on the performance of these materials as welded bands.

The critical band blank shortage was relieved shortly thereafter, but this experience indicated that more attention should be given to nonferrous materials.

Approximately three hundred 105-mm. shells were equipped with welded-copper, silicon-bronze, and aluminum-bronze bands machined to the conventional contour. The band hardnesses for these materials were Rockwell B 20 for copper, 60 for silicon bronze, and 70 for aluminum bronze. A small number of shells equipped with copper bands having a Rockwell B hardness of 40 also were included in the test.

These bands were unintentionally hardened by excessive dilution with iron resulting from improper welding techniques. Nevertheless, it was believed advisable to include these shells in the test. Standard rounds with conventional gilding-metal bands were fired before and after the test rounds for control purposes.

Two howitzer tubes, one new but stabilized and the other fully worn but serviceable, were used. Velocity, chamber pressure, range, and deflection were recorded for each control and test round. Although strain data were recorded, it was later found that band pressures could not be interpreted. The velocity spread of all test rounds fell within the range of the control rounds.

In each zone of firing there was a definite drop in the velocity level from the new tube to the fully worn tube. However, the trend in both tubes was similar. It is interesting to note that a relatively greater number of clean-out rounds were required following the aluminum-bronze test group in order to regain a stable velocity level.

A statistical study of the recorded

First three shells above show operations for welded rotating bands, left to right: shot-machined; overlay deposited; finish-machined. Second group of four shells shows operations with standard gilding-metal band, left to right: shot-machined; band seat machined and knurled; band blank annealed, pickled, and swaged into band seat; band finish-machined.

data in all phases of the test showed no significant difference between any of the test materials and the swaged gilding metal.

The development of a satisfactory welded copper rotating band for the 30-mm. high-explosive shell has been accomplished. This thin-walled shell, with a band seat, would not withstand the swaging forces necessary to seat the conventional band. When banding was achieved by providing internal support, the shell collapsed upon firing.

The welded overlay rotating band, applied directly on the bourrelet, was found to be entirely satisfactory. The elimination of the band seat, along with heat treatment after welding, effectively satisfied the requirements for this shell.

SECTIONAL views of the steps in producing the overlay banded 30-mm. shell are shown on this page. The shell is essentially finish-machined when the welded copper overlay is applied. The welding-heat-affected zone is eliminated in the subsequent heat treatment which imparts the desired mechanical properties to the shell.

A final machining operation of the band and adjacent areas completes the shell manufacture.

The 30-mm. welded overlay rotating band is applied in six or seven seconds using 270 amperes (direct current, reverse polarity) and 0.045-inch-diameter electrode and cold wires. Approximately 15 grams of copper are overlayed with a resulting hardness of R_{30T} 30-35 (R_B 21-29). Four manufacturers are in production or are setting up for automatic operation in overlaying this shell.

Welded overlay rotating bands of copper, silicon bronze, aluminum bronze, and iron have been successfully applied to hot-forged, heat-treated, 75-mm. shells. The metal was overlayed on shells which were completely finished except that they had no bands or band seats.

Welding was accomplished with no appreciable reduction of the strength and ductility beneath the overlay. These shells have been proof-fired in small quantities.

The question arose recently regarding the effect which welding might have on the properties of cold-extruded 75-mm. shells. An investigation was made, therefore, to determine the effect of overlaying copper on the mechanical properties of this shell.

Welding techniques were developed to assure satisfactory deposits which complied with specifications established for welded copper bands. Tensile specimens were then removed from beneath the overlays in accordance with standard practice. Specimens also were removed from similar locations of unwelded shells having band seats.

All specimens yielded results considerably higher than the minimum mandatory requirements. There was no significant difference in the results for specimens removed from unwelded shells and those from overlayed shells.

A more severe test also was conducted, using full section thicknesses, in order to check fully the condition imposed by the heat-affected zone. The loads required to produce yield and failure were significantly greater for those specimens having the overlayed bands than for those containing the band seat. In addition, the ductility of the metal below the overlayed band was well above the minimum requirements.

It was believed that these tests indicated the feasibility of applying welded overlay rotating bands of copper or any weldable copper alloy to the 75-mm. cold-extruded shell.

A welded copper overlay rotating band has been used extensively on the 2.75-inch rocket motor body. This motor body is composed of a very thin walled tubular member with a brazed-in bulkhead. The copper is overlayed in a position adjacent to the brazed joint.

THE success of this application, as well as many others, depends upon effective cooling of the interior of the motor body during the welding operation. Two manufacturers have gained considerable experience in the application of overlay bands to this motor body during recent production of the item.

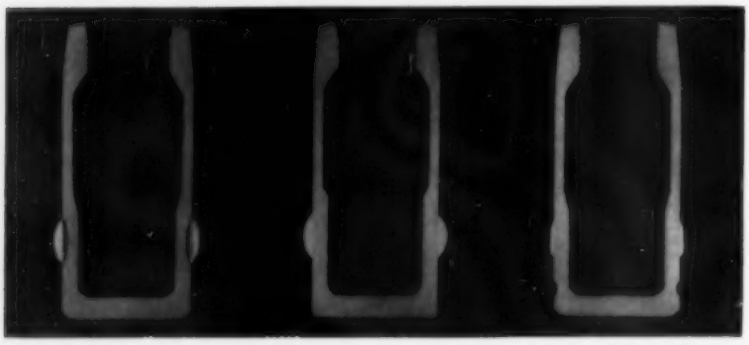
Experimental welded copper overlays have been applied for bourrelets to 4.5-inch rocket motor bodies. These were not intended to serve as rotating bands, but the application demonstrated what might be done with welded overlays on thin tubular steel without serious distortion or degradation of properties.

Research and development activities on welded overlay rotating bands have involved many projectiles in sizes ranging from caliber .50 (½-inch) to 280 mm. (approximately 11 inches). The banding process has been satisfactorily applied to all the shells which have been investigated.

There has been no general acceptance of welded overlay rotating bands for standard ammunition. The bands have literally "saved the day" however, for certain new thin-walled shells which cannot be banded by conventional methods. There has been considerable industrial activity in this field and in the manufacture of rocket motor bodies.

Future research activities on artillery ammunition have been carefully planned under a program administered by Picatinny Arsenal for the Ammunition Development Branch, Research and Development Division of the Office of the Chief of Army Ordnance.

Frankford Arsenal has written a specification for welded overlay rotating bands titled "Welding Overlays, Ferrous and Nonferrous," (as rotating bands for projectiles). This is Military Specification No. MIL-W-13562 (ORD). Related specifications are under development.



Sectional views of steps in producing a copper overlay banded 30-mm. shell. Left, welded overlay; center, heat-treated; right, band machined and finished.

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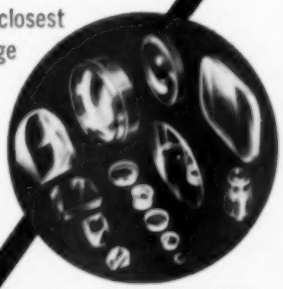

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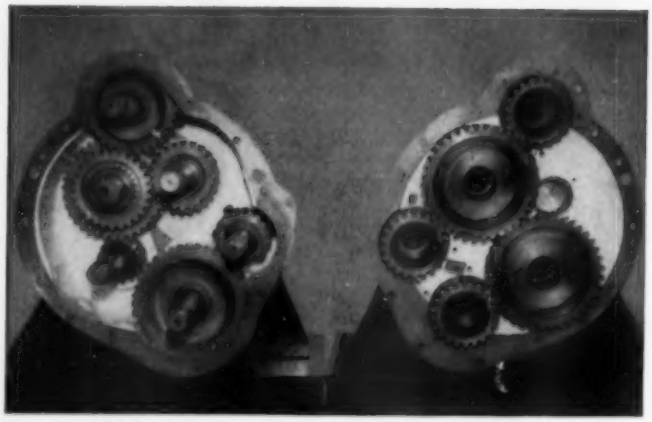

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JULY-AUGUST 1955

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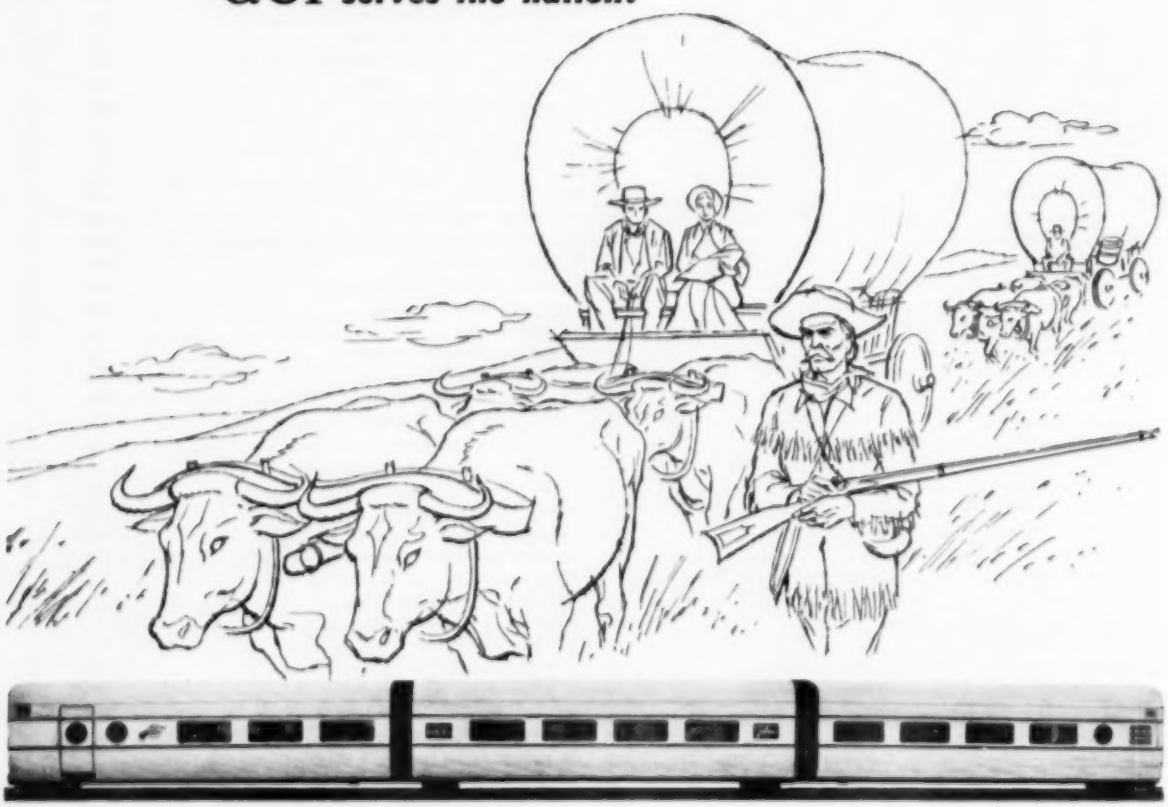

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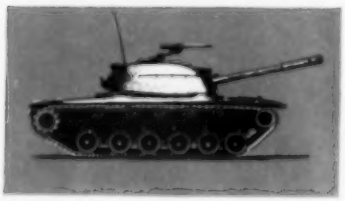

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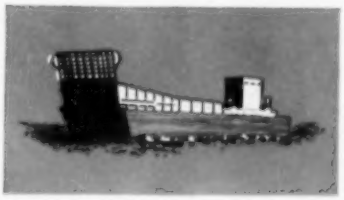

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